To Sir Andrew Clarke Bart
President of the
College of Physicians
With the Authors Compliments

HANDBOOK

OF

HOSPITAL PRACTICE AND PHYSICAL DIAGNOSIS.

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AND

PHYSICAL DIAGNOSIS.

BY

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PREFACE.

It will be conceded that medical education, after the Medical Enactment of 1886, is passing through a period of transition. An attempt is being made to create a uniform standard of examination which entails upon the student increased requirements in the scientific and practical departments of both Medicine and Surgery. It is now more than ever of importance that teaching should be conducted methodically, and in such a manner as will secure a proper arrangement of the order of study, an economy of time, and a thorough fitness of each individual possessing a registrable qualification for fulfilling a sphere of usefulness to the State. Heretofore, whilst due importance was attached to the acquiring of exact knowledge in the all-important scientific branches of the medical curriculum, inefficient attempts were made to secure an adequate amount of early training in the rudiments of medicine and surgery. The result has been that Hospital Attendance was practically postponed until the later periods of medical study; and experience, which should be fostered over a lengthened period, has, as a rule, been compressed into a short time preceding the final examination. To this is due the high percentage of rejections in medicine and surgery at the examination for the Licences to Practise.

For the purpose of obviating this objectionable mode of training, the combined Royal Colleges of Physicians and Surgeons in Ireland have introduced into the examination held at the expiration of the second year of study, the subject of Hospital Practice: including methods of physical diagnosis, application of urinary tests, as well as the principles of elementary minor surgery. In the third professional examination, held at the

end of the third year of study, in addition to the subjects of the second professional examination, the student will be examined on diseases of the respiratory and circulatory organs, and of the abdominal cavity, as well as in affections of the skin, fevers, and certain defined parts of surgery.

It is to meet the requirements of students, as far as medicine is concerned, that this work, which deals almost exclusively with physical diagnosis, has been prepared. It is intended to aid in the systematic investigation of disease, especially as it is carried out in the wards of a hospital. The chief use of such a book is to inculcate method in the examination of every organ, and to elucidate those *signs* of disease which, having a physical basis of existence, are real and tangible, as distinguished from mere *symptoms* which, though often affording a clue to the nature of existing affections, in many instances, if taken by themselves, lead but to confusion and uncertainty:—

"Such tricks hath strong imagination."

It will be observed that there are no chapters dealing with the physical signs of Diseases affecting the Nervous System, the Larynx, or the Blood. These will be dealt with, for the use of advanced students, at a future period.

In the preparation of the book, the most recent standard works upon Physical Diagnosis and upon Diseases of the Heart, Lungs, and Abdomen, have been freely consulted; the illustrations used have been borrowed from the writings of Byrom Bramwell, Gee, von Ziemssen, Graham Browne, Walsh, Roberts, and Tyson.

The Author has to express his grateful acknowledgments to his friend, Dr. J. W. Moore, Physician to the Meath Hospital, for the assistance which he has given him in the correction of the proof sheets, as well as for many criticisms and suggestions of great value and importance. The Glossary has had the advantage of being most carefully revised and corrected by him.

2 Merrion-square, *Oct.* 18, 1889.

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HOSPITAL PRACTICE.

INTRODUCTION.

The ultimate object of Medical Education is to treat disease so as to leave the patient in a condition of health. It is for this purpose that we become acquainted with the structure of the body, the functions of the various organs, and the chemical processes that are associated with the phenomena of life—the laws that regulate tissue change and decay. Having acquired a knowledge of normal function and structure, we are then prepared to investigate conditions involving perversion of function and change of structure. These conditions are so numerous and of such varying character that they must be sharply distinguished from each other; hence the necessity for a classification of disease, or a *System of Nosology*. This classification is based upon the evidences which indicate departure from normal function and structure, the study of which is known by the name of *Semeiology* or *Symptomatology*.

From the knowledge we possess of the differences in the types of disease, and the analysis which we make of the symptoms which present themselves in any given case, we are enabled to form an opinion as to its nature and pathology, and to this process the term *Diagnosis* is applied.

The symptoms of disease are classified into those which are recognisable only by the patient himself, and those which are brought within the range of the senses of the observer. The former are known as *subjective*, the latter as *objective* phenomena. The term *Symptoms* should be, in strict language, confined to subjective sensations, whilst to the different objective phenomena the term *Signs* is applied.

It is with the *Signs* of disease that Physical Diagnosis is alone concerned, and the object in this work is to treat of those conditions which, by appealing to our different senses. enable us to recognise departures from function and structure. In many instances an accurate knowledge of the nature of existing disease may be made by Physical Diagnosis without any regard being had to the Symptoms experienced by the patient. In other cases, however, it is only by carefully connecting Symptoms with Signs that we can arrive at a Diagnosis.

The Physical Signs of disease either relate to special organs, or affect the organism generally. Amongst the latter, conditions which should be specially dwelt upon refer to—

1. Facies of disease.
2. Type of constitution and state of general nutrition.
3. Decubitus.
4. Temperature.
5. Pulse; its rate and character.
6. Tongue.
7. Skin and subcutaneous tissue.
8. Appetite.

I. FACIES OF DISEASE.

The peculiar aspect and expression which are acquired in disease, usually of a chronic nature, are signs that can be appreciated only after long and varied experience. To the practised eye a quick glance at the patient's face often suggests the idea of serious organic disease; that the disease is one of malignant character; or that the patient is suffering from advanced pulmonary disease. Amongst some of the varieties of aspect and expression met with in disease are the following:—

1. *Facies Hippocratica.*—A sharp nose, hollow, listless eyes, and collapsed temples; the ears cold, contracted, and the lobes turned out; the skin about the forehead rough, distended, and parched; the colour of the whole face being lead-coloured, livid, or greenish black. These are appearances seen in persons exhausted by copious discharges, or in those dying of starvation.

2. The pinched and drawn face, with contracted brows and vertical furrows over the root of the nose, indicate the existence of pain, probably from an affection of some vital organ.

3. The extreme delicacy in appearance, thin, pallid skin, marked with blue veins, long, fringed eyelashes. and attenuated neck, suggest the existence of tubercular disease.

4. The swollen pale face, with bluish lips and cheeks, tortuous and swollen cervical veins, and mouth half opened for the purpose of breathing, is usually seen in uncompensated mitral valve disease. In advanced aortic patency there is extreme pallor.

5. A waxy or pasty aspect, with puffiness about the eyelids, suggests the existence of Bright's disease.

6. The bright red or pinkish blush on the cheeks, standing out amidst the surrounding pallor, and the clear, bright, and

sparkling eyes, indicate the hectic fever of some wasting or exhausting disease, usually phthisis.

7. The half livid, half dusky, or brownish tint of face, and suffused conjunctiva, and the stupid, listless expression and appearance of prostration, are commonly seen in typhus fever.

8. The varying transition from smiles to tears, the rapidly mobile play of features, characterise hysteria.

9. In tetanus a peculiar *facies* known as the risus sardonicus is met with. There is a premature, aged aspect, contracted and drawn features; the angles of the mouth are separated widely apart, and the lips stretched over the closed teeth, so as to produce a fixed smile.

10. A bloated, blotchy face, with partial obliteration of the movements of expression, congested looking eye, and dry, parched lips, indicate a tendency to alcoholic excesses.

II. TYPE OF CONSTITUTION AND STATE OF GENERAL NUTRITION.

The constitution of the individual deals with his habit or configuration of body, and his special tendencies to hereditary or acquired diseases (Diathesis). It is said to be *sound* when there is a harmonious development and adequate maintenance of the different structures of which the body is composed, and when it becomes weakened only by the processes envolved in senile decay.

It is *unsound* (*a*) when deficient in vitality, as in the children born of parents in advanced life, or of those debilitated by excesses. The defect of vitality may be general so as to cause death of the offspring in early life, or it may give rise to local diseases of an hereditary character, such as organic heart disease, atheroma (fatty degeneration) of arteries, renal disease, pulmonary emphysema, &c.

(*b*) It may be unsound from inherited disease, such as syphilis, gout, tuberculosis, cancer, asthma, &c.

(*c*) Unsound subsequent to birth, from defective hygienic surroundings, such as bad air, improper or insufficient food, over-work, and intemperance. These unfavourable conditions are specially apt to be efficient whenever there is any inherited tendency to such affections as rickets, phthisis, scrofula, and during the action of certain poisons like those of the eruptive fevers.

It is a condition of unsound constitution which is so potent in determining the result of acute diseases of the respiratory organs—such as acute bronchial catarrh, pneumonia, and pleurisy. The first may become chronic, or end in various lesions of the lungs of a permanent and destructive nature; the second may be delayed in the processes of resolution, or end in phthisis, &c.; whilst pleurisy often leads to conditions which, from their chronicity and exhaustive nature, imperil life, or become the starting-point of morbid processes involving other organs.

The characteristic marks of a healthy condition of nutrition are an elastic smooth skin, a clear complexion, firm well-developed muscles, and an ample deposit of fat in the subcutaneous tissue.

The amount of fat in the subcutaneous tissue varies with the habits of the individual in reference to the taking of food, activity as regards exercise, and temperament; it is largely influenced by heredity. It is commonly increased in women after the climacteric, and in young girls about the age of puberty; where there is a chlorotic tendency, obesity is often developed. Amongst men the most common cause of obesity is intemperance in the use of alcohol.

In emaciation, the fat in the subcutaneous tissue disappears,

the skin becomes thin and easily separated from the deeper parts; it is wrinkled, inelastic, and its superficial layer is disposed to desquamate in the form of fine, branny scales (Pityriasis tabescentium). The patient becomes weak and debilitated, exercise is no longer taken, the muscles steadily waste, and a condition of pseudo-paralysis is set up which ultimately confines the patient to bed.

To understand fully the processes which bring about emaciation, we must first realise the condition upon which nutrition depends. It depends upon three factors—a supply of suitable food, assimilation of it, prevention and control of waste. If food be insufficient or unsuitable, general wasting must take place; a like result must follow if assimilation be defective, or if waste be excessive. Three states which illustrate these propositions are—starvation, cancer of the stomach, and diabetes mellitus.

So also local disturbances of nutrition may be attended by local wasting or emaciation. There may be an insufficient supply of blood to the part, there may be imperfect assimilation from faulty innervation (nerve lesions), or there may be atrophy from over-use (knife-grinders' palsy).

When the disturbance of nutrition is qualitative, not quantitative, the change is spoken of as a degeneration, of which there are two principal forms—softening and induration. Occasionally local changes—not depending on blood-supply, but on disturbed innervation—are met with. As examples may be mentioned acute decubitus, herpes zoster, and the "glossy fingers" of Paget.

The special clinical points to be noted in connection with emaciation are:—

(*a.*) Its constant existence where there is high fever of a prolonged character.

(*b.*) Its marked degree in the features in malignant disease, giving to the patient a sharp, pinched aspect of countenance.

(*c.*) Its prominent occurrence in the arms and thorax in phthisis, whilst the face is least affected.

(*d.*) In abdominal disease the lower limbs and face suffer most.

In treating of the type of constitution and state of general nutrition, it is well to point out the types of the former which have been recognised, and also those conditions of defective nutrition which are enumerated amongst the cachexiæ.

The varieties of constitution are as follow:—

1. *Sanguine, or full-blooded.*—The body well nourished, ruddy complexion, pulse full and incompressible, digestion good, progressive tendency to corpulence. There is a special liability to disease of the blood-vessels (atheroma, apoplexy, fatty heart, &c.) and to arthritic affections.

2. *Lymphatic.*—Body is large, with excessive development of fat; movements slow and clumsy; face expressionless and pale; cerebration sluggish.

3. *Strumous.*—Anæmic or sallow appearance, osseous system badly developed, with tendency to enlarged joints, swollen condition of lymphatic glands, catarrhal condition of mucous membranes, upper lip and alæ nasi thickened, hair thin. In this there is a special liability to diseased bone, suppuration of lymphatic glands, and to deposition of tubercle.

4. *Nervous.*—Body thin, wiry, and active; quick, lively condition of mind; tendency to dyspepsia and sleeplessness. Persons of this temperament are specially liable to nervous affections.

5. *Bilious.*—Torpidity of mind and body; inactive liver, sluggish digestion and constipation; drowsiness; depression of spirits merging on melancholia.

6. *Gouty.*—Tendency to dyspepsia; heartburn; arthritic pains; early disease of arteries; a ruddy complexion; loaded urine. There is a special liability to attacks of gout, to Bright's disease, and to apoplexy.

7. *Rheumatic.*—Special liability to pains as a result of chill in persons well-nourished and usually of the sanguine temperament; tendency to arthritic disturbances; disposition to perspire freely.

The chief varieties of cachexia met with are—the Cancerous, Splenic, Tubercular, and Scorbutic.

Cancerous Cachexia.—In this there are progressive anæmia, emaciation, and loss of strength. The skin acquires a peculiar dirty yellowish or earthy tint, and the face is worn, pinched, and aged in appearance.

Splenic Cachexia.—This is indicated by a pale exsanguined aspect, great muscular weakness and emaciation. It is present in disease affecting the spleen and lymphatic glands.

Syphilitic Cachexia.—It may be inherited or acquired. Its chief characters are—emaciation, anæmia, and weakness, evidences of diseased bone, scars of ulcers on the skin, or in the throat or palate, opacities of the corneæ, or iritic adhesions, pegged teeth, signs of low vitality generally, such as anæmia, stunted growth, loss of hair, earthy tint of skin, &c.

Scorbutic Cachexia.—Great listlessness, depression of spirits and progressive asthenia; swollen, spongy condition of the gums; tendency to hæmorrhages and acute serous inflammations, sunken eyes, and leaden hue of skin.

III. DECUBITUS.

The position in which the patient lies in bed is termed *decubitus.* It may be horizontal, on the back (supine), or on the face (prone); more or less erect; or on the side. The limbs may be flexed or extended, fixed in one position or moved restlessly about. In great difficulty of breathing the horizontal posture cannot be tolerated, the patient being obliged to sit up, erect, in bed (orthopnœa). This is a position usually assumed by patients suffering from various forms of heart and lung disease.

In abdominal affections—peritonitis or allied conditions—the patient lies upon his back with the chest raised, and the knees well drawn up, so as to relax the abdominal muscles. In painful spasmodic attacks (colic) it is usual to find the patient bent forward in a doubled-up position, pressing his hands against his abdomen, or lying prone.

In the acute stage of pleurisy the patient *usually* lies on the unaffected side. Occasionally he lies towards the painful side, with the hand pressed against the ribs to prevent movement. When unilateral effusion to any considerable extent takes place, the decubitus is towards the side of disease.

In typhus fever, as prostration progresses, the decubitus is supine, the patient gravitates towards the foot of the bed, and the head sinks from the pillow. The aspect is one of extreme powerlessness.

In cerebral meningitis the patient often lies in a curled-up position, all the limbs being bent towards the body. When the meninges of the spinal cord are affected the head is markedly retracted, so as to relax the muscles of the back of the neck.

The term *decubitus* is also applied to bed-sores developed in lesions of the brain and spinal cord.

Acute decubitus is a bed-sore which occupies the sacro-gluteal regions, occurs usually within a few days after a severe spinal or cerebral lesion, and runs rapidly on to spreading gangrene (mortification). This bed-sore may develop in the absence of pressure.

Chronic decubitus is a bed-sore resulting from disease of the spinal cord, and occurring in those parts which are subjected to pressure, either in the lying or sitting posture. The parts attacked are the coccyx, buttocks, trochanteric and ischiatic prominences, heels, knees, vertebral spinous processes, and elbows. A slow process of dry gangrene ensues, the dead hardened tissue being thrown off, leaving a healthy granulating surface beneath.

IV. TEMPERATURE.

No more important indication of the existence of health or disease can be obtained than from an investigation of bodily temperature. Normally, the temperature taken in the axilla and mouth is 98·4° Fahr.,* that of the rectum or vagina being from 0·3° to 0·6° higher. These temperatures are subject to diurnal variations, being highest between 4 p.m. and 6 p.m., and lowest about two hours after midnight, the extreme of fluctuation representing about 1·5° Fahr., and the variations corresponding with alterations in the activity of respiration and circulation. The temperature is raised after the taking of food, during muscular exercise, and it is to a small extent influenced by external temperature. That of the *exposed*

* We prefer to give this standard to that laid down by Wunderlich—viz., 98·6°, in correspondence with the English-made thermometers, which register the normal at 98·4°.

parts of the body, as contrasted with the *interior*, may represent a difference of more than 20°.

The temperature is taken by a thermometer which, ordinarily, is graduated from 95° to 112° or 115° of the Fahrenheit scale, each degree being divided into fifths. It is provided with an index, consisting of a small detached column of mercury, which, prior to taking an observation, must be *gently* shaken down to a few degrees below the arrow mark which indicates the normal temperature. In the record of a case of disease the temperatures noted are dotted on a sheet of ruled paper, the dots being connected with lines so as to form what is termed a chart. The observations should be made at regular intervals at least twice a day, usually from 7 to 9 o'clock in the mornings, and from 5 to 7 o'clock in the evenings. The temperature is taken ordinarily in the axilla, or in the mouth, rectum, or vagina. Temperatures taken in the inguinal fold, or in the space between the thumb and the second metacarpus, are unsuitable for *general* clinical purposes. When taken in the axilla, the armpit, if perspiring, should be dried, and the bulb of the thermometer introduced below the anterior border of the pectoralis major; the arm is then brought closely to the side, the forearm being bent and carried across the chest, the hand grasping the opposite elbow. This position converts the axilla into a closed cavity, so that the temperature is slowly raised to that of the interior of the body. The time usually taken for an observation is five minutes. It may be shortened by heating the thermometer, so that the index is brought a little below the degree anticipated by palpation.

When the temperature is taken in the mouth, the bulb of the thermometer is placed under the tongue, or between the cheek and gums, and the lips are kept closed. In taking

rectal temperatures put the patient on his side, introduce the thermometer at least two inches within the bowel and keep it there with one hand, whilst the other rests upon the patient's hip. This is a matter of convenience, especially in children, as any sudden movement which would be likely to break the instrument may be prevented.

For the purposes of registering local disturbances of temperature, surface thermometers are used. They are so made that the part which contains the mercury can lie flat against the skin, whilst the other part is protected by a non-conducting material, so as to diminish as much as possible any loss of heat by radiation.

Fever, or pyrexia, is a rise in bodily temperature above the normal; it is essentially *calor præter naturam.* It may be regarded as a modification of the physiological process, by which the bodily temperature is kept above that of the external air. The modern theory of causation of fever is that it is a condition owing its origin to the existence of minute living organisms in the blood, and that it fulfils a function in being the means by which these organisms are ultimately destroyed.

Temperatures in pyrexial conditions are classified as follows (Wunderlich):—

1.	Subfebrile -	temp.,	99·5° to 100·4° F.
2.	Slightly febrile -	„	100·4° to 101·3° „
3.	Moderately febrile	„	101·3° to 103·1° „
4.	Decidedly febrile	„	103·1° to 104·9° „
5.	Highly febrile -	„	above both previous ranges.
6.	Hyperpyretic -	„	approaching 107° F., or higher.

Temperatures below normal may be classified as—

1. That of collapse, temperature below 97° F.
2. Subnormal, „ 97° to 98° „

The highest temperatures are met with in acute rheumatism, scarlatina, and certain affections or injuries of the nervous system, especially those engaging the cervical portion of the spinal cord. In the last, temperatures reaching 110° to 111° F. have been authentically recorded (Brodie, Teale); in tetanus it has been noted to reach 112·5° F. (Wunderlich). In sunstroke the temperature is often hyperpyrexial.

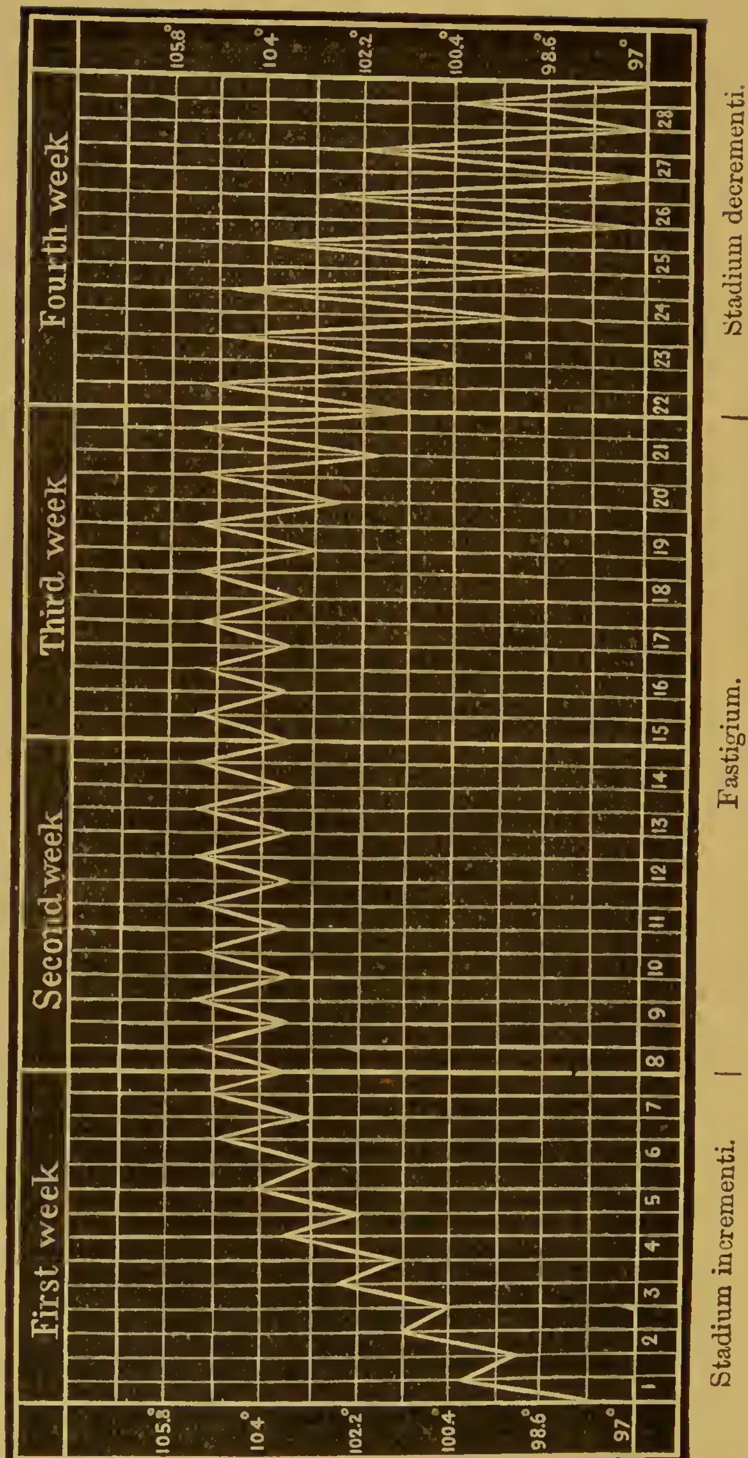
It is necessary, especially in the examination of hysterical women, to guard against simulation of high temperature, sometimes practised to elicit sympathy or attract attention. Patients may raise the mercury in the thermometer by rubbing the bulb between the folds of the night-dress, or the instrument may be held with the bulb upwards, and the index shaken to a high degree; or it may be placed in contact with warm poultices, hot water-jars, &c. A very high temperature, without a corresponding rise in the rate of the pulse, should be looked upon with suspicion.

The lowest temperatures are met with in cholera, in collapse arising from varying conditions, in congenital cyanosis, and in a rare form of congenital disease which is termed sclerema neonatorum, or skin-bound disease.

The temperature is also below normal in conditions of systemic depression following loss of blood, in starvation, during the emaciation of chronic disease, and in melancholia.

In the course of febrile diseases the following stages are recognised:—1. The initial or pyrogenetic stage (stadium incrementi), during which the temperature steadily rises until the lowest average daily temperature *characteristic* of the special disease is reached. If the rise be rapid it is indicated by a shivering fit or rigor. 2. The fastigium or acme, during which the temperature reaches its highest point, which it maintains with the usual remissions. 3. Deferves-

Fig. 1.



SCHEMATIC REPRESENTATION OF THE COURSE OF FEVER, FAHRENHEIT SCALE.
(*From Ziemssen*).

First week, gradual and steady increase of the fever. Second week, fever continuous. Third week, fever becomes gradually remittent. Fourth week, fever becomes gradually intermittent.

cence (stadium decrementi) marks the return to the temperature of health. This may be effected gradually or suddenly—when gradual, the termination is said to be by *lysis;* when sudden, by *crisis.*

The regular types of fever met with are three:—1. Continuous, where the daily fluctuation of an elevated temperature shows merely the normal difference between the morning and evening temperatures. 2. Remittent, where the difference is greater than normal. 3. Intermittent, where the daily fall of temperature reaches the normal or below it.

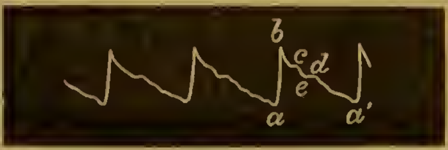
Fever with a tendency to great prostration is termed adynamic; with prominent nervous symptoms, such as sleeplessness and delirium, ataxic; with a rapid course ending fatally, malignant. When depending upon a local disease, it is symptomatic; when independent of any local disturbance, it is primary or essential.

V. PULSE.

Closely related to temperature is the rate of the pulse. It is usually taken by applying the pulp of the index, middle, and ring fingers over the radial artery at the wrist, by which not alone its frequency, but its force and rhythm are ascertained. In feeling the pulse we, moreover, determine the condition of the arterial wall, whether it is hard, cord-like, and rolling rigidly under the finger—evidences of degenerative changes brought about by a form of arteritis, or developed in old age. In comparing the radial pulse of one arm with that of the other, it should be borne in mind that the course of the two arteries may be different. There may be on one side a high bifurcation of the brachial artery, or some other peculiarity which will account for absence or diminution of the radial pulse on one side.

The motion of the blood in the artery is more accurately noted by the use of the sphygmograph—an instrument devised to record the form of the movement of the arterial pulse. For clinical purposes the varieties of sphygmograph used are those invented by Marey and Dudgeon. For expeditious use the latter is preferable to the former. The movement of the blood in the artery, as registered by the sphygmograph, shows it to be compounded of three waves—the summit, tidal, and dicrotic. The position of these waves is shown in the annexed pulse-trace:—

Fig. 2.



Healthy Pulse-trace—*a* to *b*, line of ascent; *b* to *a'*, line of descent; *b*, summit wave ; *c*, tidal wave ; *d*, dicrotic wave ; *e*, aortic notch.

The summit wave is caused by the expansion of the artery, owing to the sudden vibration in the blood column which immediately follows the lifting of the aortic valves by the discharge of the contents of the left ventricle.

The notch immediately before the tidal wave, *c*, is due to a slight collapse in the arterial wall following the oscillation called the summit-wave; that preceding the dicrotic wave, *d*, is due to a fall in pressure in the artery, which is immediately antecedent to the closure of the aortic valves; *a* to *e* on the pulse-trace, therefore, represents the entire ventricular systole; the remaining portion of the tracing, *e* to *a'*, the ventricular diastole.

The characters of the pulse refer to its frequency, rapidity, rhythm, and strength, tension, and volume.

1. *Frequency* (*pulsus frequens aut rarus*).—According to the number of beats given in a minute the pulse is said to be

frequent or infrequent. The normal rate in an adult male is about 72 beats per minute. In fever, acute diseases, cardiac palpitation, and in Graves' or Basedow's disease, the rate may reach from 120 to over 200 beats per minute. A pulse of 150 or 160, occurring in fevers is usually the precursor of death. Its rate varies with age, sex, height of body, position, bodily exercise, taking of food, psychical disturbances, and the time of the day. According to age the rate is—

At birth	130 to 140 beats per minute.
15 to 25 years	70 ,,
25 to 60 ,, -	70 ,,
60 - -	74 ,,
80 - -	79 ,,
80 to 90 years old	over 80 ,,

Position.—The pulse is more frequent standing than lying or sitting, especially if the patient who had been previously lying be asked to stand or sit up.

2. *Celerity or rapidity* (*pulsus celer aut tardus*).—These terms are employed to indicate the time which an artery takes to reach its maximum of distension and complete relaxation, or the length of time taken by the ventricular contraction. When the pulse-wave attains its height quickly the pulse is said to be *quick*; when the opposite, *slow*.

In strict language these terms should be restricted to the conditions mentioned, though their use gives rise to some confusion from their being generally applied to describe the rate of the pulse. A good instance of the *pulsus celer* is that met with in aortic patency.

3. *Rhythm.*—In the normal pulse we feel beat after beat occurring at regular intervals, but remarkable variations are met with in disease. These variations may be tabulated under the heads of dicrotism, intermission, and irregularity.

(*a.*) *Dicrotism.*—When the pulse consists of a double beat, the first large, and the second small or like an after beat, it is said to be *dicrotous.* The second beat is an exaggeration of the normal dicrotic wave, which is not ordinarily appreciated by the fingers. This is a variety of pulse commonly met with in fever, especially typhoid. When the dicrotism is very marked the pulse is termed *hyperdicrotous;* when feebly marked, *hypodicrotous.*

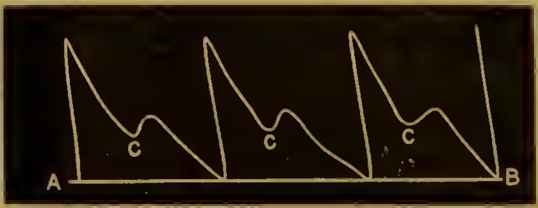


Fig. 3.—Dicrotous Pulse.

(*b.*) *Intermission.*—When the pulse drops a beat or two, in either regular or irregular succession, it is said to be intermittent. This condition may be a sign of mere functional derangement—usually of a dyspeptic character, or it may be a sign of serious organic disease of the heart, in which there is an imperfectly filled left ventricle.

Fig. 4.—Intermittent Pulse. (From BYROM BRAMWELL.)

(*c.*) *Irregularity.*—When the pulse is unequal in volume and variable in rate, it is said to be irregular. The chief varieties of irregular pulse are the pulsus alternans, p. bigeminus, and p. paradoxus.

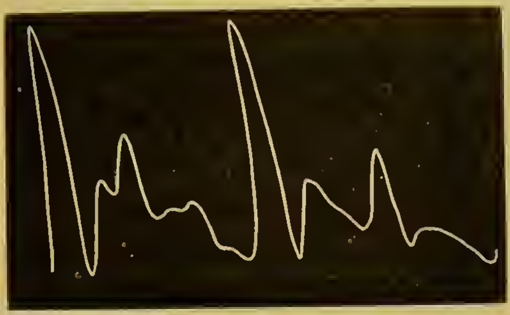


Fig. 5.—Extreme Irregularity of the Pulse. (From Byrom Bramwell.)

P. alternans, where every second beat of the pulse is exceedingly feeble, or entirely inappreciable, although the contractions of the heart can be heard.

P. bigeminus, where there is a double beat of the pulse, equal in force, followed by a long pause, occurring regularly between every two contractions of the heart.

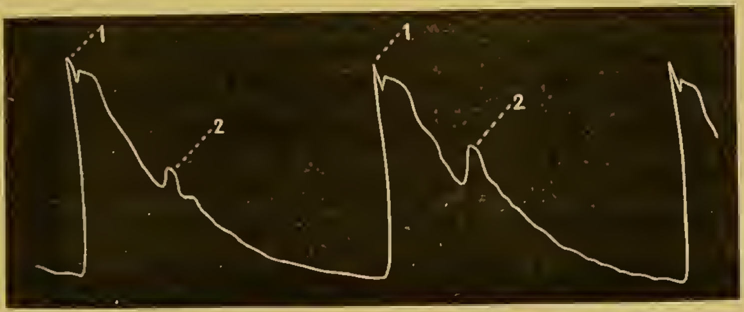


Fig. 6.—Pulsus Bigeminus. (From Byrom Bramwell.)

P. paradoxus, where an inequality of the pulse is produced during respiration so as to render it scarcely perceptible. Normally deep inspiration reduces arterial tension, lessens the degree of pulsation, and renders the pulse-rate more frequent. Forced expiration produces the reversed effects. An exaggeration of these effects during inspiration produces the p. paradoxus, or pulsus inspiratione intermittens (Kussmaul).

Fig. 7.—Pulsus Paradoxus. (From Ziemssen.)

4. *Strength, Tension, and Volume.*—By the *strength* of a pulse is meant the amount of pressure which it takes to obliterate it. According to the feeling which it gives of greater or less resistance to the finger the pulse is said to be *hard* or *soft*, compressible or incompressible.

The *tension* of the artery and of the pulse is determined by observing whether the quality of *hardness* or *softness* exists during the period of rest of the arterial wall; whether the artery is *hard* both during the pulse-beat and during diastole, or *hard* during pulse-beat and *soft* during the pause (the pulse of unfilled arteries.)

The *volume* of the pulse is measured by the size of the line of ascent in the sphygmogram, and it depends upon the amount of blood which is sent into the aorta from the ventricle. Where that amount is large, we speak of a *full* or *large* pulse, as in hypertrophy of the left ventricle. Where small, the pulse is said to be *small* or *thready*, as in aortic narrowing or mitral valve disease.

The peculiarities of the pulse met with in disease are as follows:—

Fevers.—Frequent and dicrotous.

Hæmorrhage.—Frequent and jerking.

Inflammation.—Frequent and hard.

Anæmia.—Small, soft, and feeble.

Bright's disease (cirrhotic).—Hard, tense, and bounding.

Delirium tremens.—Frequent and soft.

Peritonitis.—Hard, wiry, and frequent.

Mitral regurgitation.—Compressible, thready, and irregular. (See Fig. 8.)

Aortic regurgitation.—Hammer-like, jerky, quick; the pulse of unfilled arteries. (See Fig. 9.)

Cerebral compression.—Slow and laboured.

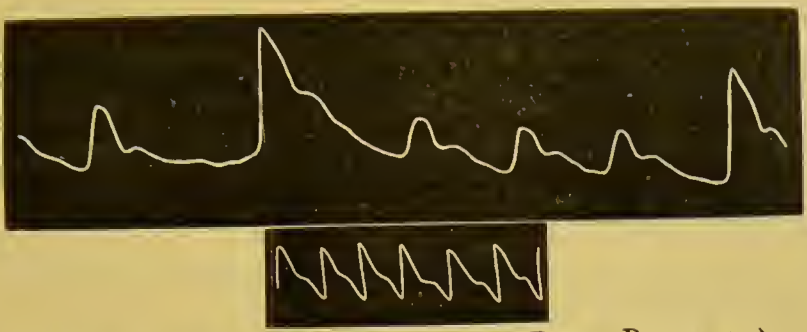


Fig. 8.—Mitral Regurgitation. (From Byrom Bramwell.)

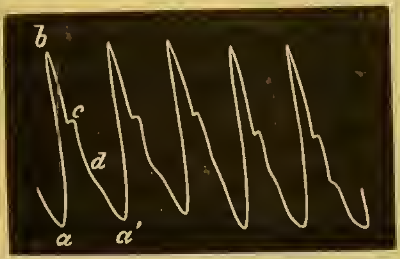


Fig. 9.—Aortic Regurgitation. (From Byrom Bramwell.)

VI. TONGUE.

The inspection of the tongue is a necessary part of almost every medical examination, and with it is included an examination of the lips, teeth, and gums.

A systematic examination of the tongue embraces—1, its subjective sensations; 2, its movements; 3, its objective appearances. The sensations of the tongue refer to taste and ordinary tactile sensibility; its movements to mode of protrusion and its function in relation to speech, mastication, and deglutition. The objective examination is made chiefly by inspection, occasionally supplemented by palpation when we desire to estimate dryness, smoothness or roughness, volume or mobility. In children, in the insane, and frequently in fevers, the tongue may have to be examined within the mouth, which in some cases must be opened by force.

A normal tongue should be protruded in a straight line, and without tremulousness; it should be soft, moist, and clean, and proportionate in size to the cavity of mouth.

In disease the following points are to be noted:—

(*a*) The size of the tongue, its shape as a whole, its point and margins.

(*b*) Firmness or flabbiness.

(*c*) Colour of mucous membrane.

(*d*) Appearance of surface—smooth, glazed, furrowed or fissured, moist, or dry.

(*e*) Condition of papillæ, especially fungiform; presence or absence of fur—if present, its nature.

Fur upon the tongue varies in extent, thickness, and appearance. It may extend over the entire of the tongue, be limited to its anterior or posterior portion, or be unilateral or patchy in distribution. It may form only a mere film, or a coating of considerable thickness. In colour it may be white, whitish-yellow, yellow, yellowish-brown, brownish-black, or black. It may be moist and easily separated, sticky and viscid, dry and cracked. It may appear and disappear with great rapidity.

Fur upon the tongue is made up chiefly of micrococci mingled with the spores and threads of the Bacillus subtilis. In it are also found other micro-organisms—sarcinæ ventriculi and vibrios, epithelium, and food *débris.* The two first-named elements are constant and essential constituents, whilst the other elements mentioned are merely accidental. The micro-organisms have a special tendency to attach themselves to the filiform papillæ. In many healthy adults, especially those who sleep with the mouth open, fur is formed during the night. During the day this is got rid of, being cleaned off by the morning meal, by the movements of the tongue against the roof of the mouth and teeth, and by the actual washing of the tongue in the act of taking fluids.

The varying colour of the fur is due to differences observed

in the micrococci. They are sometimes pale, or dark-brown in tint. Some are light yellow, others colourless. According as these tints prevail the colour of the fur varies. The coloration of the micrococci may be due to accidental causes, such as kinds of food taken, action of various staining materials, or to the colour-producing properties of the organisms. Probably it is to this colour-producing property that a black tongue owes its appearance.

The clinical indications derived from the state of the tongue cannot be said to be characteristic of special diseases except in a limited degree, as the conditions which produce fur upon it and alter its general appearance are identical in affections which have nothing else in common with each other. Individual peculiarities in shape and size must be taken into account, and also such habits as smoking, chewing tobacco, taking of certain medicines, such as iron, &c. Still there can be no doubt but that peculiarities in the appearance of the tongue exist more or less constantly in different diseases—peculiarities which often help to form a diagnosis. In the following affections the condition of the tongue is given:—

Anæmia.—Tongue pale, large, broad and flabby; usually clean, and indented at the sides by the teeth.

Typhoid Fever.—In the early stage, where there is inability to take solid food, the whole papillary surface is covered with a whitish or a yellowish-white fur, a triangular patch at the tip, with the edges, being clean and red. The papillæ are enlarged. In the late stage the tongue becomes deeply fissured, brown, dry, and destitute of fur.

Typhus Fever.—The tongue in the advanced stage of bad typhus presents the appearances characteristic of the *typhoid state.* It is dry, covered with a brownish or black crust,

fissured, and retracted. It appears as if it had been baked, and can be moved only with difficulty.

Acute Rheumatism.—The tongue is usually large and covered with a yellowish or creamy-looking fur. It is sometimes spoken of as the "blanketty tongue."

Scarlatina.—The tongue shows enlarged and prominent papillæ (fungiform), which stand out prominently amidst the whitish fur. In a short time desquamation takes place, and the tongue acquires from before backwards a smooth bright-red surface, with marked prominences scattered over it, resembling in appearance a strawberry; hence the term, "strawberry tongue."

Delirium Tremens.—The tongue is moist, thickly coated with a whitish or yellowish-white fur, and markedly tremulous.

Tonsillitis.—In tonsillitis. and acute affections involving the fauces, the tongue is usually large, moist, and covered with a thick, dirty-coloured fur, whilst the odour of the breath is very foul.

Dysentery.—In chronic dysentery, and in other forms of intestinal ulceration, the tongue becomes dry, red, glazed, and fissured.

In the examination of the tongue the appearance of the lips should be noted. They may be preternaturally red, purplish in hue and swollen, as in great venous congestion; or pale and exsanguined, as in anæmia; presenting herpetic or other eruptions; dry and fissured, or covered with blackened crusts (sordes). The condition of the teeth should also be observed—whether absent, loose, decayed, or covered with sordes or tartar.

The colour and consistence of the gums should be noted. They are sometimes soft and spongy, overgrowing the teeth, and exuding blood (Scurvy). In lead-poisoning a blue line

is observed along the edge at their junction with the teeth—*Burton's blue line.* It is due to the sulphuretted hydrogen in the mouth precipitating the lead as a black sulphide, between the margin of the teeth and gums. It is absent where the teeth have been lost.

The buccal mucous membrane frequently presents depressions corresponding to the teeth in anæmia, chlorosis and dyspepsia.

In states of debility and deranged digestion, the tongue and other parts of the mouth may become coated with small flakes like curd, called aphthæ. Sometimes the patches extend by coalescence, and form a thick coating of fur, felt-like in character, which involves the entire mucous membrane of the cheeks, tongue, and throat. This condition is apt to occur at the extremes of life, in infancy and old age, or in wasting and debilitating complaints.

VII. SKIN.

There are many conditions referable to the skin that are at once striking and of great value in the diagnosis of disease. These conditions may be tabulated as follows:—

(*a*) Pallor.
(*b*) Cyanosis.
(*c*) Icterus.
(*d*) Pigmentation.

No notice is taken here of the affections of the skin met with in the different fevers, or of those ordinarily termed "Skin Diseases."

(*a*) *Pallor.*—This is a condition which is evidenced by a waxy-white colour of the whole cutaneous surface, a blanched condition of the visible mucous membranes and of the nails,

and a pearly-whiteness of the sclerotics. It is developed whenever there is—(1) a great diminution in the volume of the blood in circulation; (2) a diminution of the red blood-corpuscles; (3) an unfilled state of the capillaries.

Diminution in the volume of the blood is due either to hæmorrhage, or to profuse serous exudation, or to defective supply or mal-assimilation of food.

Deficiency of red blood-corpuscles is found in chlorosis and other anæmic conditions. It is still undecided whether there is merely a diminution of the red cells, or, in addition, a diminution of hæmoglobin in the individual corpuscles (oligocythæmia and oligochromæmia).

An unfilled condition of the capillaries may be produced by emotional disturbances, such as fear; in syncope, which is caused by enfeeblement or momentary cessation of the heart's action; and in cardiac diseases where there is an imperfect filling of the arteries, as in mitral valve disease.

The skin presents sometimes an earthy-hue, instead of a distinctly white appearance. This is associated with cachexia (bad habit of body), such as is induced by cancer, malaria, leukæmia, &c.

Frequently pallor is accompanied by a tinge of blueness (cyanosis), from disturbances in the circulation through the heart or lungs. Occasionally the whiteness of the face is relieved by a pink or bright red blush on the cheeks. This is seen in chlorosis, from a preternaturally dilated condition of the capillaries. A bright red blush over the malar bones—hectic blush—often attends the fever of consumption.

(*b*) *Cyanosis.*—Cyanosis is a discoloration of the skin and visible mucous membranes, varying from a light bluish tint to a dark purple. It is usually most marked in the extremities, and wherever the skin is most delicate and vascular.

Thus it is best observed on the tip of the nose, the lobes of the ears, eyelids, nails, tips of elbows, and fronts of knees. The mucous membranes of the lips, mouth, tongue, &c., are also discoloured, and the superficial veins are often enlarged and stand out as blue knotted cords.

Cyanosis in its most marked degree is often present at birth, or is developed a short time afterwards. It is then due to a congenital malformation of the heart.

When it exists it is an indication that the blood is surcharged with carbonic acid and deficient in oxygen. Hence the discoloration becomes intensified by exertion, mental excitement, exposure to cold, &c.

Cyanosis is produced in affections of the respiratory organs in two ways—(1) by conditions which prevent the access of air to the lungs, as in obstructive affections of the larynx and trachea, and in acute and chronic bronchial catarrh; (2) by a lessening of the breathing surface, as in diseases affecting the air vesicles, such as pneumonia, extreme pleural effusion, emphysema, hypostatic congestion of lungs, pneumothorax. In pneumothorax, and where the obstruction to respiration is apt to be suddenly set up, particularly in the young and plethoric, cyanosis is specially well marked. In such cases no time is given for compensatory expansion of the lungs to take place; in the plethoric the blood-vessels are well filled, hence oxidation takes place slowly.

Cyanosis in cholera-asphyxia is caused by the difficulty which the tarry blood has in passing through the pulmonary capillaries.

Lastly, cyanosis is produced in affections of the abdominal organs which force upwards the diaphragm and prevent the adequate expansion of the lungs, such as ascites, ovarian or other abdominal tumours.

Local cyanosis is produced by compression or obliteration of one or more of the large venous trunks. Familiar instances of this are the congestion of the forearm produced by the bandage employed in venesection, and the appearance of the face in coughing.

The livid hue of the rigor of cold is due to the influence of a very low temperature on the exposed parts causing contraction of the superficial arterioles and capillaries, and the consequent retardation of the blood-current.

(*c*) *Icterus.*—Icterus or Jaundice is a yellow discoloration of the skin, conjunctivæ, and the tissues generally, from their being impregnated with bile pigment. The colour varies from citron-yellow to green or dark-brownish green (melano-icterus). The parts most affected are those which are usually covered, as the breasts, chest, abdomen; whilst those most exposed and red in hue undergo least change, as the face, hands, and forearms. The yellow hue is distinctly marked in the conjunctiva, through which in health the white sclerotic is distinctly visible. This enables us to recognise slight alterations in coloration—the most familiar being the slightly yellowish tint observed in what is ordinarily spoken of as "biliousness," which so usually follows a debauch.

It should be borne in mind that except in very deep varieties of discoloration the yellow tint of icterus is not visible by gas or candle-light.

Sometimes a yellowish discoloration of the conjunctiva simulating jaundice is met with in old persons, from a deposition of fat in the meshes of the submucous tissue.

In icterus there is a constant change in the colour of the urine, which varies from a deep yellow to dark brown or even black. The alteration is due to the presence of bile pigment (bilirubin). It is detected by the addition of a drop

or two of fuming nitric acid to some of the urine lying on a white plate. Aronnd the nitric acid a play of colours takes places (green, blue, violet, red, and yellow).

A strip of linen or a piece of white filter paper dipped in the urine becomes yellow in colour.

The existence in the urine of bile acids (glyco- and tauro-cholic acids) is a matter of doubtful significance. The test employed to determine their presence is Pettenkofer's. A few drops of syrup are added to the liquid which is supposed to contain bile acids, and afterwards a small quantity of strong sulphuric acid, taking care not to develop too great an amount of heat by the addition of the acid. A beautiful violet tint appears if the acids of the bile are present. The test is, however, not satisfactory, for if much bile-pigment is present the sulphuric acid so blackens the liquid as to prevent the violet colour being seen.

In icterus the perspiration also contains bile-pigment, and the patient's linen in connection with the armpits and those places in which perspiration is abundant is stained yellow.

Icterus should not itself be regarded as a *disease*—an entity due to a single cause and capable of being dealt with without reference to its mode of production. It is merely a sign of disease which almost always owes its origin to some obstruction to the passage of bile from the liver, the retained bile passing from the ducts into the surrounding blood-vessels owing to increased lateral diffusion. Amongst the causes of obstruction to the passage of bile from the liver are:—

1. Gastro-duodenal catarrh, which causes tumefaction of the lining membrane of the common bile duct.
2. Existence of foreign bodies—gallstones, &c.—in that duct.
3. Narrowing or occlusion of duct, due either to inflammation or to the pressure of tumours against its walls.

Apart from the occurrence of icterus from obstruction are those conditions under which it arises without there being any obstacle to the flow of bile, such as jaundice due to certain poisons in the blood, or to an acute destructive inflammation of the cells which secrete the bile. In such cases there is a disintegration of the red blood corpuscles with a liberation of their colouring matter, and hence the jaundiced appearances. This condition is termed *hœmatogenous* jaundice to distinguish it from jaundice from obstruction, *hepatogenous* jaundice.

Amongst the symptoms often co-existing with jaundice, and dependent upon it, are itching of the skin especially at night, infrequent pulse, and a tendency to hæmorrhages. The rate of the pulse may be reduced to 50, 40, or 30 beats in the minute. Infrequent pulse is met with only in jaundice from obstruction, when unattended with feverish disturbance.

(*d*) *Pigmentation.*—The most common varieties of pigmentation met with in hospital patients are—

Bronzing.
Pityriasis versicolor.
Chloasma.
Ephelis ab igne (Melasma Caloricum).
Argyria.

Bronzing.—This condition depends upon the deposit of dark pigment in the deep layer of the cuticle, so as to produce the appearance ordinarily existing in the dark races. It varies in intensity from a dull yellowish brown to the bluish black colour of the negro, the latter tint being of late development. The discoloration is usually best marked on the back of the neck, between the legs, in the axillæ, on the backs of the hands, and on the face; it becomes strikingly marked on a recently blistered surface. The pigmentation is frequently

noticeable on the mucous membrane of the lips, and in that of the tongue and cheeks, so as to resemble the appearance found in the mouth of the mastiff and other dogs. With the dark skin, the pearly white sclerotics, and the pallid fingers and nails form a marked contrast.

Bronzing is a condition of pigmentation met with in disease of the supra-renal capsules, or semilunar ganglia, constituting one of the most prominent symptoms of what is known as "Addison's Disease."

Long continued exposure, and dirty habits, especially when associated with pediculosis (*pediculus*, the louse) sometimes give rise to pigmentation like that observed in "Addison's Disease." So close is the resemblance that it may be difficult to distinguish the two forms of pigmentation one from the other. This is the affection specially described by Vogt, which is known by the name of vagabond's discoloration or disease (Vagabonden-krankheit).

Pityriasis versicolor.—Pityriasis versicolor, or tinea versicolor, consists of yellowish brown spots occurring in irregularly shaped patches or blotches of considerable extent, which give rise, when scratched, to a branny or furfuraceous desquamation. It is met with principally on the front of the chest, spreading towards the abdomen, between the shoulder-blades, upon the upper arms, on the flexures of the elbows and the borders of the axillæ. This condition is specially noticeable amongst hospital patients, and in those who are in habit of wearing flannel next the skin. It occurs very frequently in phthisical patients, and is generally associated with a want of cleanliness. It depends upon the growth of a fungus, the *Microsporon furfurans*, in the substance of the epidermis.

Chloasma, though ordinarily applied to tinea versicolor, is in reality a different affection. It is a dirty yellow or brownish

discoloration, which occurs chiefly on the face, though it may appear over the body generally, or follow the application of a blister or other counter-irritants. It is met with chiefly in women during pregnancy, from disordered menstruation, or various other diseases of the sexual organs.

Ephelis ab igne (*Melasma caloricum*).—An appearance of streaky brown stains coursing through the skin, which is of the normal colour, and breaking it up into irregular islets so as to give it a marbled aspect, is termed *Melasma caloricum.* It is met with in parts long subjected to heat—the back of the neck, backs of the hands and wrists, and on the legs from the knees downwards in those who are in the habit of toasting their shins at the fire.

A condition of defective pigmentation of the skin is termed *albinism.* It depends upon a congenital absence of colouring matter in the skin, hair, iris and chorioid. The skin is milky white, the hair yellowish white, and the iris rose-coloured; nictatation and oscillation of the eyeballs (*nystagmus*) are present. There is usually intolerance of light, and the head is held downwards.*

In connection with pigmentation, the occurrence of sudamina may be adverted to. They are minute elevations of the cuticle, the size of a pin's head, filled with a watery fluid (miliary vesicles), and found in great numbers over the chest and abdomen, where there is profuse sweating, as in typhoid fever or acute rheumatism. They are formed by an accumulation of sweat, which is unable to escape through the ducts, being effused under the horny layer of the skin which is raised to form a vesicle.

* Chromidrosis is a name given to a rare form of pigmentation of a bluish colour, produced by the secretion of coloured sweat. For a full account of the condition, see paper in Dubl. Quar. Journal, 1869, by Dr. A. W. Foot.

Argyria.—This is a slate-like stain of the skin, resembling the appearance met with in congenital cyanosis, and caused by the deposition of metallic silver, or some of its compounds, in the tissue of the skin. The staining may be general, or exist only on those parts which are exposed to sunlight. It is met with chiefly in epileptics who have been treated for their disease by the administration of nitrate of silver, or in persons who have been in the habit of applying solution of nitrate of silver to the throat for diseased conditions of it.

Subcutaneous Tissue.—The affections of the subcutaneous tissue which demand notice are two—*Dropsy* and *Emphysema.*

Dropsy is an accumulation of serous fluid in the subcutaneous cellular tissue, or in a serous cavity. It depends upon more serous fluid being exuded by the blood-vessels than can be taken up by the absorbents (lymphatics and veins). The fluid accumulates in the spaces of the subcutaneous cellular tissue, but is easily driven out of its meshes into neighbouring spaces by the pressure of the finger. This pressure leaves after it a deep pit which slowly disappears—a condition termed "*pitting on pressure.*" It is due to the skin losing its elasticity, the part affected becoming swollen, white, tense, and shining. Normally a certain amount of serous exudation is constantly thrown off from the capillaries, but this fluid is at once taken up by the lymphatics. It is only when there is any defect in absorption that the fluid accumulates, and hence the presence of dropsy. Dropsy, when confined to the subcutaneous cellular tissue, is known as *œdema* or *anasarca;* when accompanied by effusion into a serous cavity—such as the peritoneum or pleura—it is called *general dropsy.*

Serous effusion into the peritoneum is termed *ascites;* into

the pleura, *hydrothorax;* into the pericardium, *hydropericardium;* into the ventricles of the brain, *hydrocephalus.*

Anasarca causes most swelling wherever the tissue is most lax, and where its occurrence is favoured by gravitation. Hence it is specially well marked about the ankles, in the genitals, about the eyelids, and in the tissue over the back of the sacrum.

The causes of dropsy are twofold:—(1), obstruction to the flow of blood through the veins (passive dropsy); (2), an abnormally watery condition of the blood (hydræmic dropsy).

Passive dropsy is met with in diseases of the heart and lungs, which obstruct the return of venous blood from the periphery. It is most marked in the dependent parts of the body, as about the ankles; when first developed it disappears when the patient lies for a time in a horizontal position, vanishes after a night's rest, but returns during the day as he moves about.

Dropsy from obstructed venous circulation may also occur in diseases of the liver or peritoneum, the dropsy being at first local—*i.e.*, confined to the cavity of the peritoneum; but when the fluid in this cavity has accumulated to such an extent as to impede seriously the flow of blood through the inferior cava, œdema of the lower limbs sets in.

Hydræmic dropsy depends upon the changes which the abnormally watery condition of the blood induces in the structure of the blood-vessels, and the greater facility with which the blood serum diffuses itself, owing to its impoverishment in respect of albumen and fibrine, or its containing an excess of water from diminished renal secretion or arrested cutaneous transpiration. This is the kind of dropsy met with in acute and chronic diseases of the kidneys (Bright's disease). It occurs independently of position, and shows

itself first in the face, particularly in the lower eyelids. It has a special tendency, in its early stage, to shift its position, being of a migratory or metastatic character. For instance, it frequently leaves the face and invades the hands and legs, or suddenly leaves the legs to appear in some internal cavity.

Dropsy from hydræmia, independently of renal disease, is met with in the terminal stage of chronic wasting affections, such as phthisis, chronic suppuration in connection with diseased bone, &c., or from defective nutrition following insufficiency of food (œdema pauperum). It is usually associated with great pallor, and is confined to the ankles or calves of the legs. In rare cases anasarca occurs after scarlatina, or where there is suddenly suppressed perspiration (catching cold), without any disturbance of the renal function. This is due to an abnormal permeability of the cutaneous blood-vessels following chill, or produced by the scarlatinal poison. Such a condition is known as *essential dropsy.*

Local dropsy is associated with obstructive disease of a large venous trunk which arrests or retards the circulation through it. This is frequently brought about by clotting of the blood in the vein itself (thrombosis), or by the lodgment in the vein of a clot carried from some distant part (embolism). Thrombosis is usually met with in the saphenous, femoral, or iliac veins, giving rise to phlegmasia dolens, or in the veins of the upper limbs from the pressure of tumours upon them.

Emphysema (*subcutaneous*).—This is a swelling usually of a limited character, but sometimes involving the entire subcutaneous cellular tissue. The swelling is of an elastic nature and does not pit readily on pressure. Its characteristic feature is, that when the affected part is pressed on with the

finger a peculiar fine crackling or crepitation is felt resembling that noticed by pressing a portion of healthy lung between the fingers.

Emphysema is caused by internal or external rupture of organs which contain air, such as the trachea and lungs, œsophagus, stomach, or intestines; or from injury to cavities containing air, such as the antrum and frontal sinuses.

Wound of the lung either from a broken rib or from a stab is the most common cause.

It sometimes accompanies effusion of air into the cavity of the pleura (pneumothorax), or arises from rupture of dilated air vesicles.

Emphysema may also be produced by the development and spread of gases generated in diffuse gangrene (mortification).

Conditions of Skin in Disease.

The clinical indications derived from the condition of the skin are as follow:—

(1) It is very thin and easily detached from deeper structures in phthisis and acute wasting diseases.

(2) It is full and tense in the early stage of the eruptive fevers; hard in erysipelas; gritty or shotty in small-pox.

(3) There are clubbing of the fingers and incurvation of the nails in tubercular disease and chronic pleurisy. In the former the skin becomes pallid, and the hair thin and downy in character.

(4) In tubercular abdominal disease and in chronic dysentery the skin has a dry, harsh feel.

(5) In delirium tremens the skin is soft and perspiring.

(6) In acute rheumatism the skin is usually bathed in perspiration, which has a sour odour. It often presents miliaria (sudamina) upon its surface.

(7) Colliquative sweating is a common symptom in phthisis.

(8) In diabetes mellitus the skin is dry, rough, and harsh; branny, especially in the furrows of the hands. Usually the dryness of the skin is associated with anthrax, boils, or some variety of papule.

(9) In a rigor, or from exposure to prolonged cold, the skin is coarse and granular to the feel, from the contraction of the muscular fibres in the skin, the arrectores pilorum. This is the condition known as cutis anserina, or goose-skin.

VII.—APPETITE.

The appetite in disease may be (1) lessened, (2) increased, or (3) perverted—

Lessened appetite or anorexia is present usually in the various fevers, in most acute affections, in chronic organic diseases of the stomach and bowels, in certain forms of insanity, and generally in all forms of serious disease.

Increased appetite is met with whenever there is a necessity for an increased supply of food, as after fever, or during the processes of growth. When extreme it is termed "boulimia," or "bulimia," a condition existing in diabetes mellitus and occasionally in helminthiasis (worms).

Perverted appetite occurs generally in females as a result of pregnancy, hysteria, or chlorosis, or it may exist in the insane. Chalk, cinders, slate pencils, particles of straw, &c., are sometimes swallowed. The condition is termed *pica*.

Thirst is greatly increased in diabetes, in cholera, in severe diarrhœa, in hæmorrhage, and after profuse diuresis, such as sometimes follows an hysterical seizure.

CHAPTER I.

PHYSICAL EXAMINATION OF THE ORGANS OF RESPIRATION.

THE methods employed in the investigation of the diseases of the lungs are—

1. Inspection.
2. Palpation.
3. Percussion.
4. Auscultation.

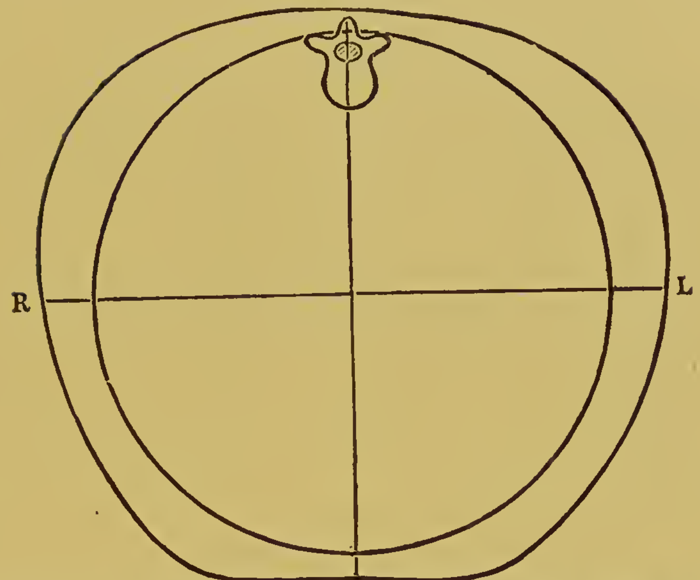
Mensuration and Succussion are sometimes spoken of as special methods, but the former will be alluded to in the section on Inspection, the latter in that on Auscultation.

I. INSPECTION.

Inspection of the chest enables us to determine—(1) the shape of the thorax, (2) the precise changes which it undergoes during the movements of respiration. In carrying out this method it is well to have the patient stripped to the waist, and standing or sitting in a good light opposite to the physician. This rule has, of course, to be modified in regard to women, or those who are in a weakly state, as well as in other circumstances. When in bed the patient may be examined as he lies evenly upon his back, and subsequently when he assumes the sitting-up position.

Shape of Thorax.—The normal adult thorax is, upon transverse section, the shape of an ellipse, having the long axis from side to side. The short axis, or antero-posterior measurement, bears to the long, or transverse one, a certain definite proportion, and it is an alteration of this proportion which constitutes abnormality, such as we find existing in general and local deformities (Fig. 10).

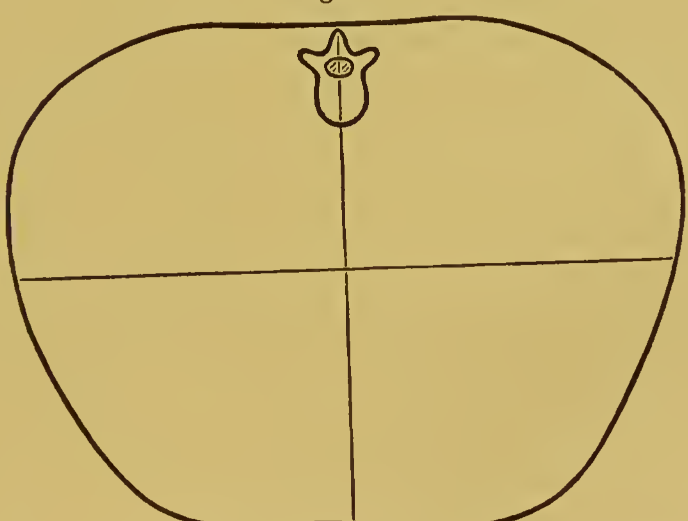
Fig. 10.



Circumference = 40·5 centimetres. Transverse section of chest of an infant aged 9 months. (A circle is drawn within the tracing for the sake of comparison.) From Gee.

At birth, the axes of the ellipse are nearly equal, but as growth progresses they become more and more disproportionate, until full maturity is reached (Fig. 11).

Fig. 11.



Circumference = 89 centimetres. Transverse section of healthy adult chest upon level of sterno-xiphoid articulation. From Gee.

Towards old age a tendency is developed to return to the form met with in childhood. All deformities which are either congenital or acquired, and which affect the length of the thorax, the direction of the ribs, the size of the intercostal spaces, the position of the sternum and spine, affect also the shape of the horizontal ellipse. Normally the two sides of the thorax are symmetrical, the semi-circumference of the right half being, in right-handed persons, about one inch greater than that of the left in a measurement taken on a line with the nipple. A slight arching forward of the anterior walls commences on each side below the clavicle, rising gradually towards the nipple (which is situated in the fourth intercostal space), and then sloping downwards towards the lowest ribs. Below the fifth rib in men is the depression known as "Sibson's fold," which marks the lower border of the pectoralis major. The sternum and spine are erect, the scapulæ are in symmetrical positions, the manubrium of the sternum joins the body of the bone at an angle prominent in front—the "Angulus Ludovici."

In the examination of the chest it is usual to speak of certain lines and parts which indicate special regions and situations. The vertical lines used are the mid-sternal, side-sternal, parasternal (midway between side-sternal and nipple lines), nipple (or mammillary), mid-axillary, scapular (a line passing through the inferior angle of the scapula), and the vertebral groove.

The horizontal lines are shown by reference to the clavicles, ribs, intercostal spaces, nipples, and sterno-xiphoid articulation.

For the purposes of localising accurately the physical signs of disease, the chest is divided into a number of regions—the anterior, posterior, and lateral—which may be described briefly as follows :—

The anterior region is subdivided at the sides into supra-

clavicular, clavicular, infra-clavicular, mammary, and infra-mammary regions; in the centre, supra-sternal, upper-sternal, and lower-sternal.

Posteriorly, on each side, are the supra-spinous, infra-spinous, infra-scapular, and inter-scapular.

Laterally, the axillary and infra-axillary.

The boundaries of these regions and the parts in relation to them are briefly appended.

Supra-clavicular; Boundaries.—Above, a line drawn from outer part of clavicle to upper rings of trachea; below, the clavicle; inside, the edge of the trachea. Contents—triangular apex of lung, portions of subclavian and carotid arteries, and of the subclavian and internal jugular veins.

Clavicular.—The region comprises the inner half of the clavicle, behind which lies lung substance. On the right side the arteria innominata lies at the inner confines of the region, the subclavian artery on its outer side. On the left side the carotid and subclavian arteries lie deeply, almost at right angles with the bone.

Infra-clavicular; Boundaries.—Above, the clavicle; below, the lower margin of the third rib; outside, a line falling vertically from the coracoid process—the so-called "acromial line;" inside, the edge of the sternum. Contents—the upper lobe of the lung; on the right side, the superior cava and part of the arch of the aorta; on the left, the edge of the pulmonary artery.

Mammary; Boundaries.—Above, lower border of third rib; below, the sixth rib; outside, the continuation of coracoid vertical line; inside, the edge of sternum. Contents—on the right side, the lower lobe of the lung, the right arch of diaphragm, a part of the right auricle, and about one-third of the right ventricle; the hepatic convexity, which rises

usually to the fourth intercostal space. On the left side, the anterior edge of the lung passes obliquely downwards and outwards from the level of the fourth costal cartilage, to leave a free space for the heart. The left auricle and left ventricle, with a small portion of the right ventricle, lie in the space, as well as the anterior points of the division of the lobes of the left lung.

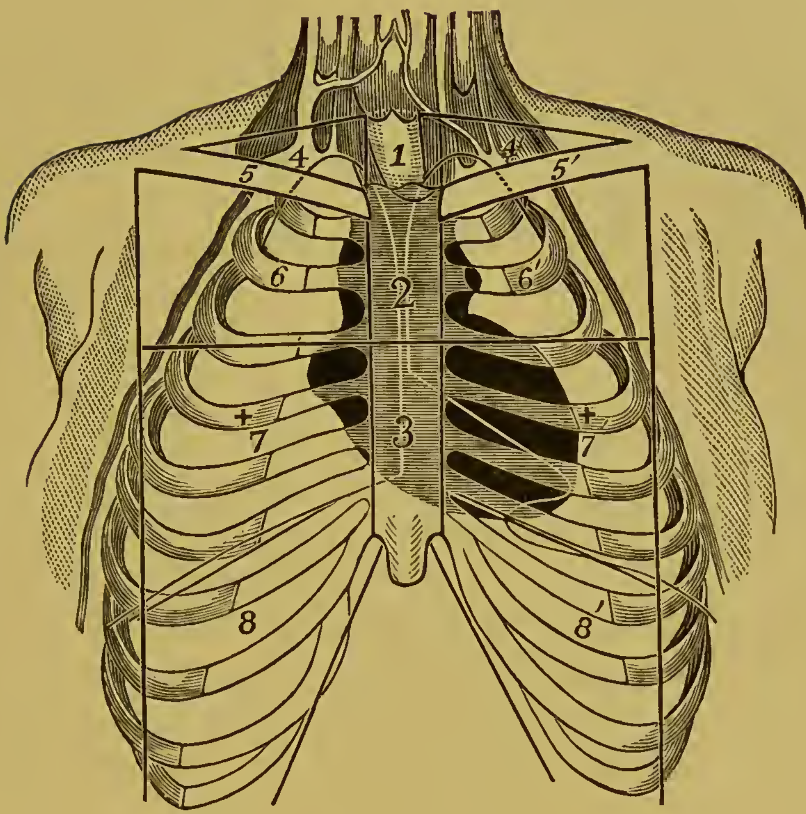
Infra-mammary; Boundaries.—Above, a line drawn obliquely downwards from the sixth costal cartilage; below, the margin of the false ribs; outside, the continuation of the coracoid vertical line; inside, the sternum. Contents—on the right side, the liver with a thin intervening portion of the right lung—the hepatic flexure of the colon lies behind the liver at lower part; on the left side, the stomach, the edge of the left lobe of the liver, and the anterior edge of the spleen.

Supra-Sternal.—This corresponds to the trachea. Occasionally the pulsations of the arch of the aorta can be seen and felt in this region.

Upper Sternal.—This corresponds to the portion of sternum lying above the upper border of the third ribs. Contents—the left, and part of the right, innominate vein, the ascending and transverse parts of the arch of the aorta, the pulmonary artery from its origin to its bifurcation, the aortic and pulmonic valves, the trachea and its bifurcation. The inner slanting edge of both lungs almost join in the middle line, opposite the third costal cartilage.

Lower Sternal.—This corresponds to remainder of sternum. Contents—the greater part of the right ventricle and part of the left, the tricuspid and mitral valves, the portion of the liver separated from the heart by pericardium and diaphragm, a part of the distended stomach, and the edge of the right lung and a small portion of the left.

Fig. 12.



REGIONS OF THE FRONT OF THE CHEST.

(*Modified after* WALSH, *by* BYROM BRAMWELL.)

1. Supra-sternal.
2. Upper sternal.
3. Lower sternal.

4, 4′. Right and left supra-clavicular regions.
5, 5′. Right and left clavicular regions.
6, 6′. Right and left infra-clavicular regions.
7, 7′. Right and left mammary regions.
8, 8′. Right and left infra-mammary regions.

Axillary.—This extends downwards from armpit to continuation outwards of the lower boundary of the mammary region. Contents—upper lobes of the lungs, with, deeply placed, the main bronchi.

Infra-axillary.—The remaining portion of the lateral aspect of the thorax. Contents—the sloping lower edge of the lung, with, on the right side, the liver, on the left the spleen and stomach.

Supra- and Infra-spinous Regions.—These correspond to their respective fossæ, and are in relation with lung substance.

Infra-scapular.—This region lies between the lower angle of the scapula above, the twelfth rib below, the spine internally and the infra-axillary region externally. Contents—as low down as the eleventh rib, the lung; on the right side, the liver; on the left, internally, the intestines; externally, the spleen; on both sides, close to the spine, a part of the kidney.

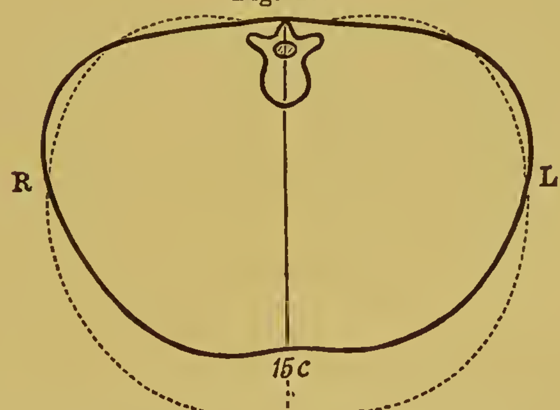
Inter-scapular.—This extends from the inner border of the scapula to the spine, from the second to the sixth dorsal vertebræ. In contains on both sides lung substance, the main bronchi, and bronchial glands; on the left side, the œsophagus, and a part of the thoracic aorta.

Mensuration.—For the purpose of estimating alterations in shape of the chest, a single or double tape measure and calipers of various patterns are used. For recording accurately the shape of the thorax, and contrasting one side with the other, an instrument called the Cyrtometer is used. The cyrtometer introduced by Woillez consists of two halves of jointed pieces of whalebone, which can be accurately applied to the surface of the chest, and after its removal the various curves can be traced upon paper. A simple form of instrument, made of pieces of soft metal connected by a hinge, is also used. The accurate measurement of the chest is termed *Mensuration.*

Whilst perfect symmetry of the two sides of the thorax, even in the most healthy, rarely exists, the differences are trivial in character, and relate principally to the increase in one side, which is due to muscular exercise. The irregularities in shape, which are merely accidental and compatible with health, are known as physiological heteromorphisms; those which are the result of disease, pathological heteromorphisms. Marked deviations from the normal shape are termed sub-typical, and of these it will be necessary to describe the following varieties, all of which may exist independently of lung disease:—

I. Alar Chest (Paralytic thorax) (Fig. 13).
II. Flat Chest.
III. Transverse Constriction of the Chest.
IV. The Pigeon Breast (Fig. 14).
V. The Rickety Chest (Fig. 15).

Fig. 13.



Circumference = 59·0 centimetres. Alar thorax, taken from a child. Dotted line indicates shape of healthy chest. From Gee. (Auscultation and Percussion).

I. *Alar Chest.*—The chest is long, narrow, and shallow, the antero-posterior diameter being specially diminished, sloping supra- and infra-clavicular regions; wide intercostal spaces, from diminished power of the intercostal muscles;

wing-like projection of the shoulder blades from diminished power of the scaleni, and falling downwards of the shoulders. The manubrium joins with the body of the sternum at an angle projecting backwards, the angle of Louis. This is known as the paralytic or phthisical thorax, as although those possessing it may be free from lung disease, still, when affected with any lesion of the respiratory organs, they are specially prone to delayed or imperfect processes of resolution.

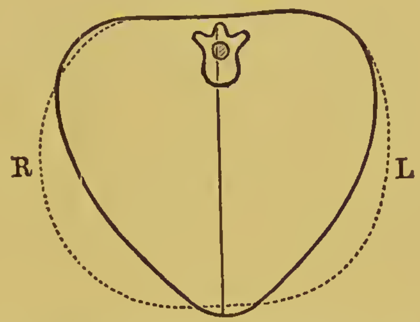
II. *Flat Chest.*—This form, like the last, predisposes to the occurrence of phthisis. It is characterised not alone by a diminution in size of the sectional area, but by the flattening of the front of the chest, due to the cartilages of the true ribs losing their curve and becoming straight. In extreme cases the sternum may be depressed below the level of the cartilages, the curve of which is inverted, so that a section of the chest may be reniform in shape. In most other respects the flat chest resembles the alar chest.

III. *Transverse Constriction of the Chest.*—This is a deformity of frequent occurrence, and consists in a depression or concavity which runs outwards and slightly downwards on each side from the lower end of the sternum along the fifth, sixth, and seventh ribs, becoming lost towards the mid-axillary line. It is due to an impediment to inspiration occurring during childhood, by which the lower portion of the lung fails to expand, and then, from the yielding character of the ribs in infancy or childhood, the chest wall falls in during inspiration and the depression so formed becomes often permanent.

A deformity resembling this in the existence of a well-defined horizontal sulcus, corresponding to the attachment of the diaphragm to the xiphoid cartilage, is met with in

cases of dyspnœa of old standing occurring in aged, emaciated persons, who have been suffering from chronic emphysema. The depression is known as "Harrison's Sulcus."

Fig. 14.

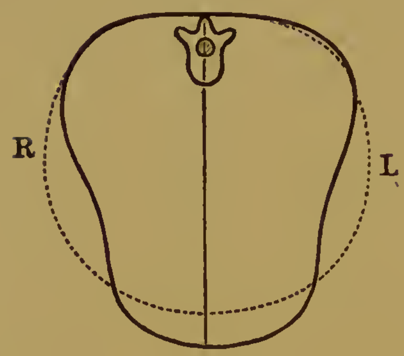


Circumference = 57·5 centimetres. Pigeon breast. Taken from a child of 7 years. Dotted line indicates normal shape. From GEE.

IV. *The Pigeon Breast.*—In this deformity (see Fig. 14), the ribs from their angles pass in a straight direction to the sternum instead of forming a convexity outwards. A projecting breast, narrow in front, and with the greatest transverse diameter at the costal angles, are the characteristics. With these are a well-marked transverse constriction in the situation before described, and an angular projection at the end of the sternum caused by the sharp bending backwards of the xyphoid appendix. The cause of the pigeon-shaped breast is long-existing or frequent recurrence of impediments to respiration at a time when the ribs are plastic, or specially yielding, as in rickets. It is apt to follow chronic pulmonary catarrh, whooping-cough, or collapse of the lungs.

V. *The Rickety Chest.*—In this case the ribs, instead of passing in a straight direction towards the sternum, present a curve with the concavity inwards as they approach their articulations with the costal cartilages. This curvature inwards is due to the softened ribs during the descent of the diaphragm in respiration yielding to the atmospheric pressure from without.

Fig. 15.



Circumference 42·75 centimetres. Rickety chest. Dotted line indicates the normal shape. From Gee.

The anterior portions of the ribs yield most, as the softest parts of the ribs are at or near their costochondral articulations. There is, moreover, in the rickety chest a considerable thickening of the ends of the ribs, giving to the chest-wall, or each side, a beaded appearance known as the "rickety rosary."

CHANGES IN THE SHAPE OF THE CHEST FROM DISEASE.

In disease of the respiratory organs pathological changes in the shape of the thorax may be divided into deformities, involving—

(1) Dilatation or enlargment, either bilateral or unilateral.

(2) Contraction or diminution, either bilateral or unilateral.

(3) Local changes involving (*a*) prominences; (*b*) depressions.

(1) Dilatation of *bilateral* extent is most often observed in well-marked emphysema of the lungs (distension of the air vesicles). Here the thorax is enlarged in every dimension—length, breadth, and depth; its walls are more prominent in front and behind, the ribs and sternum are markedly convex, and the intercostal spaces widened. The chest possesses a

more or less globular form, and is said to be *barrel-shaped.* The enlargement of the chest exceeds that capable of being produced by the fullest possible inspiration, as frequently in this disease there is an increase in the length and breadth of the costal cartilages. Usually in emphysema the change in shape of the chest involves only the upper and middle parts of the chest, the lower part being unaffected, or it presents the transverse depression before described. In some cases the spine is so much arched, and the shoulders carried so far forward that the front of the chest remains flat, forming a contrast to the rounded shoulders. In children, as a result of suffocative catarrh, a bilateral enlargement of the front of the thorax may take place from acute emphysema of the anterior portions of the lungs, a condition which subsides with the resolution of the catarrh.

The differences in the shape of the thorax in emphysema depend upon the intensity of the process of distension of the air vesicles, the amount of lung implicated, and the situation of the lesion.

A form of thorax like that met with in emphysema may be seen in persons who stoop habitually, and in some cases of spinal curvature.

Theoretically, bilateral enlargement of the thorax is also caused by the presence of air or fluid in both pleural cavities, and by paralysis of the diaphragm.

Dilatation, *unilateral* in form, involves the same changes on one side as those observed on both in emphysema. Its presence is marked by contrast with the unaltered side, the difference being estimated either with the cyrtometer, or, ordinarily, by grasping both sides with the two hands, the thumbs being placed tip to tip upon the spines of the vertebræ. The general characters of the enlargement are—rounded

shape; antero-posterior semi-diameter lengthened, transverse diminished; shoulder raised; spine curved to unaffected side. All these changes may be noted by a method of inspection often employed—viz., looking from behind the patient obliquely over his shoulders and front of chest. The usual causes of unilateral enlargement are effusion of air or fluid into the cavity of the pleura, or vicarious hypertrophous emphysema of one lung. More rarely tumours of the mediastinum or lung, and certain forms of pneumonia may give rise to it.

In pleuritic effusion the distension of the side is attended with a certain amount of flattening, or, in rare cases, bulging of the intercostal spaces. This is due to partial paralysis of the intercostal muscles from inflammatory œdema, and in part from the pressure of the fluid upon the lung limiting the range of its movement.

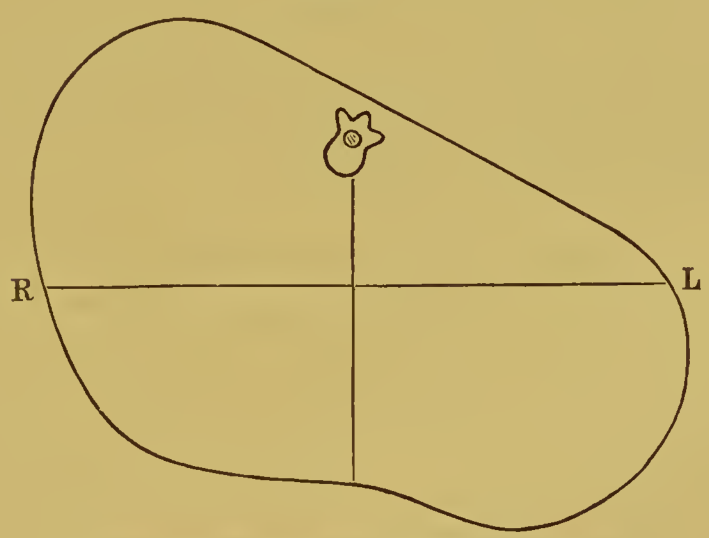
(2) *Contraction or diminution*, *bilateral* in distribution, involves a general diminution in the cavity of the chest greater than can be produced in a healthy chest by the deepest expiration. The general characters of shape are those noted under "the flat chest," but in a more exaggerated degree. It is a condition met with only in those of a phthisical habit. Paralysis of the intercostal muscles is said to produce bilateral diminution.

Contraction or diminution, *unilateral* in form, involves a diminution in size of the circumference and antero-posterior diameter of one side of the chest, whilst the transverse diameter is increased. The side presents a more or less angular appearance, having lost its rounded contour, the ribs lie close together, the point of the shoulder is lowered, and the spine is bent, having its convexity directed towards the sound side. The nipple is displaced towards the sternum, the

scapula towards the spine, the diaphragm in an upward direction, whilst the anterior mediastinum shrinks towards the side of disease. The displacement of the diaphragm and mediastinum explains the altered position of the liver and heart in contraction of the right side, and of the displacement of the cardiac impulse upwards and to left side, in left-sided contraction.

The causes of unilateral diminution are—adhesions in the pleura following empyema or chronic pleurisy, wasting diseases of the lung, such as tubercular phthisis, and interstitial pneumonia or cancer. It is met with sometimes in children from the collapse of the lung which follows plugging of the main bronchus.

Fig. 1 .



Shape of Chest in Scoliosis. Taken from Gee.

Unilaterial contraction is simulated by a condition known as *Scoliosis.* It is a deformity of the chest, produced by a rotation of the vertebræ round their longitudinal axis, by which one side of the chest is made protuberant in front, and contracted behind, and *vice versâ.*

(3.) Local changes involving (*a*) prominences; (*b*) depressions.

(*a*) Prominences of portions of the chest-walls are met with in various pathological conditions—chiefly in diseases of accumulation within the thorax. The most common of these are—circumscribed pleural effusion; pericardial effusion, especially in the young; pointing empyemata; phthisical excavations; aneurysms, sometimes in cardiac hypertrophy and dilatation, and in tumours of the lung and mediastinum.

(*b*) Depressions are met with whenever there is any considerable shrinking of the lung, as in phthisical disease and in old pleuritic adhesions. In the former it is generally observed at the upper part of the chest, under the clavicles. A cup-shaped depression, of considerable extent, is very often met with at the lower part of the sternum and costal cartilages. It has been noted as following unilateral pleurisy, pericardial adhesions, whooping-cough, croup, or conditions attended with a chronic impediment to inspiration.

THE MOVEMENTS OF RESPIRATION.

The movements of the chest in respiration are classified under two types—the *costal type* observed in women in whom the enlargement takes place chiefly in the upper part, owing to the increased mobility of the upper ribs, being effected mainly by the intercostal muscles; in men the movement is most marked in the lower part, owing to the action of the diaphragm constituting what is termed the *abdominal type* of respiration. In extraordinary breathing the movements are upper costal *in all persons.*

The movements observed during inspiration are those of *expansion* and *elevation.* In the former there is a general divergence of the walls of the chest from their central axis,

so that the anterior, lateral, and posterior parts diverge from that axis (*expansion movement*); in the latter the seven or eight upper ribs rise upwards (*elevation movement*). During expiration the walls of the chest pass to their position of rest by the converse movements of retraction and depression. The circumference of the chest during forced inspiration should not be less than two inches greater than during a forced expiration, or more than three inches.

The number of respirations in healthy adults varies from 16 to 18 in the minute, being somewhat more frequent in women and children. There is usually one respiration to four beats of the pulse, constituting what is termed the *pulse-respiration-ratio.* The frequency of respiration will be increased in health by whatever conditions tend to increase the rate of the pulse—such as physical exertion, mental excitement, posture of body, &c.

In disease abnormal rapidity of breathing is called *dyspnœa*, and this term is also applied to conditions where breathing is fuller or deeper than usual (laboured breathing), as in cases of paralysis of the phrenic nerves.

ALTERATIONS OF CHEST MOVEMENTS IN DISEASE.

The chief alterations of the chest movement in disease relate to their frequency and rhythm, as well as to their general character.

The general movements may be *diminished*, *excessive*, or *perverted.* As examples of each may be mentioned the condition of partial immobility of the side of the chest in pleurodynia and the early stage of pleurisy (diminution); the strong muscular efforts made to overcome some obstruction placed *low* in the chest, as in asthma (excess); the irregular jerky movement, with inspiratory recession of the chest-walls, seen

in obstruction of the upper air-passages, as in œdema glottidis, laryngitis, laryngismus stridulus, &c. (perversion).

The most important changes in the respiratory movements are those involving perversion and alteration of rhythm, but whilst pointing out the peculiar features of such perversions, it may be well to put in a tabular form the different causes of the conditions which produce dyspnœa.

DYSPNŒA.

Dyspnœa, or difficulty of breathing, may in general terms be stated to be caused by any condition which interferes with the normal exchange of gases in the blood. This disturbance may be effected in five ways :—

(1.) By diminution of the respiratory, or breathing surface, as in collapse of the lung, pneumonia, destructive pulmonary disease, &c.

(2.) Narrowing of the respiratory passage, as in affections of the glottis, bronchial tubes, &c.

(3.) Diminution of red cells, as in various forms of anæmia.

(4.) Disturbance in the respiratory mechanism, as is produced in many forms of heart disease, in certain nervous lesions, &c.

(5.) Febrile disturbance (heat-dyspnœa). The preternaturally warm blood acts as an irritant upon the respiratory centre, and the respirations are greatly increased in frequency.

The forms of dyspnœa met with in disease are—

(*a.*) Inspiratory dyspnœa.

(*b.*) Expiratory dyspnœa.

(*c.*) Non-expansive dyspnœa.

(*d.*) Thoracic—*i.e.*, respiration wholly thoracic.

(*e.*) Diaphragmatic—*i.e.*, respiration wholly abdominal.

(*f.*) Paroxysmal dyspnœa.

(*g.*) Cheyne-Stokes' respiration.

(*a.*) Inspiratory dyspnœa occurs most usually in children as a result of croup, or during the acute stage of a pulmonary catarrh. It will also be met with where there is any serious obstruction to the passage of air through the larynx or trachea, or in acute œdema of both lungs. During inspiration a recession, more or less deep in character, takes place in the part of the chest in relation with the lower ribs just below the level of the nipples.

(*b.*) Expiratory dyspnœa involves a great increase in the length and force of the expiratory movement, the extraordinary muscles of expiration being called into play. The relative lengths of inspiration, expiration, and the pause are completely deranged, inspiration being often a mere gasp, whilst expiration is laboured and prolonged. This form occurs in some cases of obstruction to the passage of air through the upper air-passages, but in a special degree wherever there is any impairment of the elastic force in the lung, or rigidity of the chest-walls, as in emphysema. It is also met with in asthma and congestion of the lungs.

(*c.*) Non-expansive inspiration occurs where there is some impediment to the expansion of the lung, either from its impermeability to air, or from pleural effusion, pleuritic adhesion, or pneumothorax. It may be associated with expiratory dyspnœa, as in emphysema, where there is permanent expiratory expansion. The chest-wall is moved powerfully as a whole, but no local or general expansion takes place.

(*d.*) Thoracic.—In this form breathing is carried on by the movements of the thorax alone, representing an exaggeration of the costal type of respiration. It occurs in conditions which interfere with the action of the diaphragm, as in paralysis of the muscle, or pressure on it from extreme

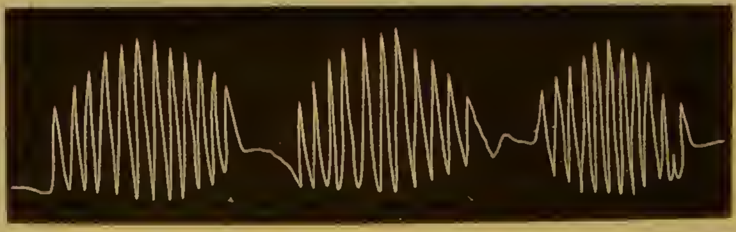
pericardial effusion; it is also met with in peritonitis, ascites, and abdominal tumour.

(*e.*) Diaphragmatic.—This represents an exaggeration of the type of breathing met with in children in whom the breathing is carried on almost entirely by the diaphragm. It occurs in its marked form in spinal paralysis where the muscles which move the ribs are involved, and in tetanus. It may also be seen, unilaterally, in pleurisy, pleurodynia, and phthisis.

(*f.*) Paroxysmal dyspnœa, as its name implies, signifies that the difficulty of breathing comes on in fits or paroxysms, leaving the patient in the interval free from distress. This form is met with frequently in heart disease (cardiac asthma), in bronchial asthma, and in some affections of the larynx.

(*g.*) Cheyne-Stokes' respiration is a peculiar form of dyspnœa which is usually met with in cases of weak and dilated heart, often associated with fatty degeneration and aortic disease, and in certain affections of the nervous system. A peculiar disturbance of the respiratory rhythm takes place by which the respirations are increased in rapidity and depth up to a certain point, subside at the same rate, becoming gradually slower and shallower, until finally there is a complete cessation of respiration (period of apnœa), which may last for several seconds.

Fig. 17.



Diagrammatic representation of Cheyne-Stokes' Respiration. (From Byrom Bramwell.)

CHAPTER II.

PALPATION OF THE CHEST.

By palpation is meant the application of the hand to the surface of the chest. The object of employing this method is threefold—first, to ascertain the form and movements of the chest, as a whole, or of its different regions, confirming or correcting the impressions already received by inspection; secondly, for the purpose of detecting certain vibrations which are conveyed to the chest wall under normal or abnormal conditions; and, thirdly, to ascertain the *frequency* of respiration. In this method the palmar surface of the fingers and hand is placed with a uniform but gentle pressure on the surface; or, when it is desired to combine inspection with palpation, the observer, standing behind the patient, who is stripped to the waist and seated upon a chair, places the fingers of both hands on the subclavicular regions, and then observes, from above and behind, the degree of movement on both sides of the chest. Employed in this way, palpation is of value in determining the difference between the *expansion* and *elevation* of local regions of the thorax, whilst by inspection the extent and character of the general movement is ascertained. The two methods are usually employed together, but palpation enables us to recognise thrills or impulses which are imperceptible by the eye.

Independently of inspection, palpation is employed to determine the existence of what is known as vocal fremitus.

VOCAL FREMITUS.

Vocal Fremitus means the vibration of the walls of the thorax which can be felt, when a person speaks or sings, by putting the hand on the chest. The intensity of the thrill varies with the depth and loudness of the voice; the diameter and position of the bronchus in relation to the chest walls in which the vibrations are conducted; the amount of resistance offered to the passage of the sonorous vibrations by the walls of the chest; and, lastly, upon the distance of the spot under examination from the larynx. It is much more marked where the pitch of the voice is low, as the vibrations, being fewer in number but of greater intensity or depth, are far more perceptible. Hence, it is intensified in adult men possessing a bass voice, whilst it is frequently absent in women and children.

It is more intense on the right side, in consequence of the greater width, direction, and position of the right bronchus. The right bronchus is placed nearer to the vertebral column than the left, which has behind it the aorta.

It is most marked in thin persons, who have a scanty amount of subcutaneous fat and ill-developed muscles.

It is more intensely marked over the larynx and trachea, than over the inner parts of the subclavicular and interscapular regions, whilst it is but feebly marked inferiorly.

In disease the vocal fremitus is *diminished* or *abolished*, whilst at other times it is *increased*, and these changes are usually unilateral, or affect but a limited area of the chest-wall, hence their value in point of comparison.

Vocal Fremitus diminished.—Vocal fremitus is diminished or lost in conditions where the lung is separated from the chest-wall, or where the lung is rendered impermeable to air. These are also the states which influence *vocal resonance* to which

attention will be directed in the section on Auscultation. Pleural effusion and pneumo-thorax are the conditions with which diminution or loss of vocal fremitus is generally associated—especially the former—and its diminution or absence constitutes a valuable sign in distinguishing pleural effusion from pneumonic consolidation of the lower lobe of the lung. Vocal fremitus is also lessened or lost whenever the main bronchi become blocked by plugs of mucus, which prevent the passage of the waves of sound into the tubes beyond the site of obstruction. This condition is met in chronic bronchial catarrh, suffocative catarrh, and in some cases of pneumonia. It is well in such cases, before ascertaining the amount of fremitus present, to get the patient to clear his bronchial tubes of secretion by a forcible cough. Any solidification of the lung of a sufficiently massive character to produce obliteration of the bronchial tubes diminishes or causes extinction of thrill.

Vocal Fremitus increased.—Vocal fremitus is increased by conditions which increase the density of the parenchyma of the lung. The most common of these conditions is pneumonic consolidation. Here we find that the vibrations of sound developed in the larynx are prevented from becoming diffused in the alveoli, which are blocked up by infiltration, so that the vibrations are concentrated and conducted to the surface by a firm homogeneous structure—*i.e.*, the hepatised lung. Vocal fremitus may, however, be lost in pneumonic consolidation owing to the main bronchus being cut off from communication with the diseased part of the lung by superabundant bronchial secretion, or where the lung is so packed by exudation as to produce obliteration of the bronchi.

Three other conditions in connection with fremitus in disease remain to be examined :—*Pleural Fremitus*, *Bronchial Fremitus*, and *Fluctuation in the Thorax*.

A point of some value, though not generally specified, is worthy of notice in connection with palpation in cases of pleurisy with effusion. Where the effusion is moderate in amount, vocal fremitus is usually found to be intensified over the part of the chest which is above the level of effusion, so that the contrast between it and the lower area which corresponds to the liquid effusion is most marked.

PLEURAL FREMITUS.

Pleural Fremitus is a peculiar vibration of a rubbing character, which is communicated to the hand when the two surfaces of the pleura are roughened by the exudation of lymph. The sensations conveyed may be that of *rubbing*, *grating*, or of a faint *grazing* character. It is not often met with in the early stage of pleurisy, but, after absorption has taken place and the two roughened surfaces come in contact, this sign is frequently noticed and is of value in determining the absence of fluid exudation. The sense of friction is usually observed only towards the end of inspiration, especially of a forcible nature, but it may be felt occasionally during expiration as well. In certain dry forms of pleurisy (*Pleuritis Sicca)* which are unattended with fever it may be felt almost over the entire surface of the affected side.

BRONCHIAL FREMITUS.

Bronchial Fremitus.—In cases where the bronchial mucous membrane is swollen and the lumen of the tubes diminished in size, and partially filled with fluid secretion, a vibration is set up during the entrance and exit of the current of air which is conveyed to the surface and produces what is known as *bronchial fremitus.* It may be compared to the sensation obtained by applying the finger to the string of a

bass violin when vibrating. It is felt over a large area, usually by applying one hand to the front and the other to the back of the chest. It differs from *pleural fremitus* in not being irregular or jerky, in being as marked during inspiration as expiration, and in its temporary diminution or disappearance after a violent fit of coughing attended with expectoration. It indicates the existence of diffuse bronchial catarrh, such as is frequently met with in emphysema, or constituting what is known as suffocative catarrh (*peripneumonia notha*).

FLUCTUATION IN THE THORAX.

Fluctuation in the Thorax.—In cases of an extreme amount of pleural effusion a sense of fluctuation may be experienced by placing the palmar surface of one hand at the back or side of the chest and tapping on the front with the fingers of the other hand.

Occasionally, when the intercostal spaces are very wide and tense, fluctuation may be obtained by two fingers placed apart in the same interspace. In empyema of the left pleural cavity a pulsation may, sometimes, be communicated to the fluid and chest wall by the motions of the heart—*pulsating empyema*.

CHAPTER III.

PERCUSSION OF THE CHEST.

Percussion of the chest is the art of striking it with the fingers or a percussion hammer, so as to produce a sound. It was discovered as a method of investigation by Auenbrugger, who published a work on the subject in 1761; but before his time percussion of the abdomen was employed, even by Hippocrates, to distinguish dropsy in the abdomen from tympanites. The labours of Auenbrugger were largely aided and perfected by Piorry and Skoda, to whom most of the present advanced state of our knowledge on percussion, of both the chest and abdomen, are due.

Percussion is practised by two methods, *Immediate* and *Mediate*.

Immediate percussion consists in striking the chest directly with the points of the fingers. It is a method at present used only in percussing the inner half of the clavicles (which act as pleximeters).

Mediate percussion is employed by placing one of the fingers of the left hand, usually the index or middle finger, in uniform apposition with the surface about to be struck. The pulps of two or more fingers of the right hand being accurately brought into line, strike short, quick, hammer-strokes upon the finger placed on the chest. The movements of the hand should proceed from the wrist, not from the elbow or shoulder, and the strokes should be of a rebounding character, and made, except in deep percussion, as lightly as will be sufficient to produce a sound which satisfies the practised ear.

In deep or forcible percussion, however, the strokes must be made with considerable force and celerity. A modification of *mediate* percussion is sometimes employed by using a pleximeter and a percussion hammer. The pleximeter is an oblong, oval plate of ivory, fitted at each end with small vertical projections, roughened on the outer surface. In percussing very uneven surfaces a pleximeter made of caoutchouc, and shaped like a bent tongue spatula, may be used. The pleximeter is kept closely applied to the part about to be examined, and it is then struck with the hammer. The hammer employed is that introduced by Wintrich.

No great advantages can be claimed for the use of hammer percussion. It has the disadvantages of eliciting vibrations from a wider area than that under examination; it does not permit of the recognition of the finer differences in sounds; and, lastly, it involves, to a great extent, the loss of the sense of resistance which is appreciated by ordinary finger percussion. Hence, comparatively few physicians now employ either the hammer (plessor) or the pleximeter.

Before discussing the character and mode of production of the different sounds audible on percussion in health and disease, it is well to refer briefly to some points in connection with sound in general. This is all the more necessary, as this method of examination of the chest has given rise to views of an extremely discrepant nature, so much so that it would be impossible upon any basis to harmonise conflicting opinions.

SOUND IN GENERAL.

All auditory sensations refer to *noises* or *musical sounds*. A *noise* is a mere jumble of impulses. "They dash confusedly into the ear, and reproduce their own unpleasant confusion in our sensations" (Tyndall). The vibrations which produce

noises possess no periodicity, being irregular in their repetition; or the period of their reproduction is so complex as not to be readily appreciated. A musical sound is one in which the vibrations occur at periodical intervals; the mere impulses which constitute it repeat themselves with perfect regularity.

In all sounds, whether noises or musical, we recognise the character of *loudness* and *duration*. *Loudness* depends upon the amplitude of the vibrations—that is, the amount of disturbance of the air or other medium produced by them. *Duration* depends upon the number of constituent waves forming the sound—that is, the time during which wave follows wave so closely as to be indistinguishable from each other by the ear, and to constitute a single sound. *Loudness* is to be regarded as synonymous with intensity in dealing with percussion sounds.

Pitch refers strictly only to musical sounds, and to the position which they have with regard to the musical scale—*i.e.*, high or low. It is determined by the wave length of the vibrations: the shorter the wave length, the larger the number of consecutive vibrations which fall upon the ear in a second of time, and the higher the *pitch*. In many *noises* we can, in a limited degree, recognise a pitch, according as the multifarious vibrations which produce them tend to recur at fixed or periodic intervals.

Quality in reference to sounds implies their timbre or tone, the character which serves to distinguish notes of equal pitch from each other according to the way in which they are produced. It is *quality* or timbre which distinguishes the bass from the baritone, or the musical sounds generated by one instrument from another. The explanation of this difference lies in the fact that the "overtones," which accompany the "fundamental tone," vary in number and

prominence in different instruments; and, as the *quality* of the sound depends upon the overtones, we have consequently differences in the sensations produced by the fundamental tone.

In reference to noises, *quality* may be applied to distinguish those vibrations which approach nearest to the orderly character and regularity of recurrence of musical sounds. In this way we recognise differences in banging, rustling, creaking or crackling noises.

PROPERTIES OF THE PERCUSSION SOUND.

Strictly speaking, the normal percussion sound over the chest cannot be termed a musical sound, inasmuch as it lacks *timbre.* As this property, however, is acquired in disease, we may discuss percussion sounds as possessing (1) *loudness,* (2) *duration,* (3) *pitch,* and (4) *quality, timbre,* or *tone.* Percussion *noises* may be shortly described as dull or toneless, the use of these terms being justified further on.

(1.) The *loudness* of the percussion note depends upon the force of the percussion stroke, and on the conditions of the sonorous material.

(2.) Its *duration* depends upon the elasticity or swaying power of the sounding body.

(3.) *Pitch,* as before stated, depends upon the swiftness with which the periodic waves follow each other. There are many degrees of pitch between tones of the lowest and highest note, but these can be reduced to the following heads:—

Tympanitic, which is the note yielded by percussing over the belly in tympanites. It resembles somewhat the sound of a drum.

Sub-tympanitic is the note yielded by healthy lungs in their normal state of distension.

Tracheal, or tubular tones, are those obtained by percussing over the trachea when the mouth is open. (The *tracheal resonance* of Williams).

Osteal tones are of the highest pitch, being yielded by the hard, solid tissues, such as cartilage and bone.

(4.) *Quality.*—This term, in reference to a percussion note, represents tone or *timbre*, and it may vary from the normal condition—that of an impaired musical quality, but of comparative pureness and clearness—to a degree of tone dulling down to utter dulness, that is, a *noise* wholly bereft of tone. Hence the expressions *dulness* and *clearness* or *resonance*, in reference to percussion. Walsh points out in reference to these terms that they really represent not simple, but complex conditions, the individual elements of which are capable of separate analysis; and further, that they are not scientifically correct terms, inasmuch as they are not enumerated amongst the properties of sound by acoustic philosophers. But we have to bear in mind that they are terms which have been woven into the literature of medicine, and that to discard them would lead to confusion in our interpretation of the physical signs of disease of the lungs, as laid down in the classics of the subject. Furthermore, Dr. Gee, a high authority, insists not alone that these terms should be retained, but that they are scientifically correct—that is to say, *dulness* means *absence of tone or timbre*, and varying degrees of *clearness* or *resonance* correspond with the admixture in different proportions of *noises* and *tones*. It has been pointed out that no percussion sound in health is ever perfectly clear, but on the other hand, in disease the note yielded on percussion in the thinnest healthy persons, may become, by contrast, *hyper-resonant.*

In dwelling upon the characters of sound in percussion it

is convenient here to point out the distinction drawn between *superficial* and *deep* percussion.

Superficial percussion means the sound obtained by a light and gentle tap, whilst deep percussion implies an increased percussion stroke, sometimes as hard as the patient can bear. By gradually increasing the force and the stroke we influence progressively the parts lying beneath it.

PERCUSSION OF THE CHEST IN HEALTH.

The thoracic percussion sound we have seen cannot be regarded as a pure musical sound. It is of complex nature and may *shortly* be regarded as subtympanitic in quality. Various opinions are held with regard to its mode of production, but probably it is correct to assign three factors in its causation—(1) the vibration of air in the large and middle-sized bronchial tubes ; (2) the vibration of the thoracic walls ; (3) the vibration of air contained in the air vesicles and bronchioles.

Dr. Gee holds that the sound is wholly produced by the first factor, as he believes, with Wintrich, that the pulmonary vesicles and bronchioles are, both singly and collectively, too small to resonate—that they are conducting structures and no more. It would be out of place here to enter on any discussion upon this point. That the vibration of air in the air vesicles contributes to the sound appears likely from the changes in it, which are produced by any condition which alters the degree of tension of the parenchyma, and by the fact that, in bronchitis, though the tubes may become filled with mucus, as long as the air vesicles and bronchioles are free, there is scarcely any alteration of the sound on percussion. That the vibration of the thoracic walls contributes also to the formation of the sound, is shown by the lung being less

resonant when removed from the chest and inflated than when lying normally within the thorax, and that when, by pressure of the hand upon the thorax, the vibration of any part of it is prevented, the *pitch* of the note is altered. A strong argument in favour of thoracic vibration influencing the sound is the alteration which is produced on percussion in cases of deformity of the chest, without there being any apparent thickening of the walls, as in curvature of the spine, where the projecting side of the chest often produces a dull or toneless sound, although there is no affection of the lung present.

It is scarcely necessary to dwell at any length upon the topographical percussion of the chest—the variations in the percussion-note in the different regions can be realised only by practice and experience. There are, however, a few points to which attention may be drawn at the commencement of the study of this method of diagnosis.

The sound produced by percussion over the ribs, sternum, clavicles, and spines of the scapulæ, is more or less osteal in tone. On the clavicle, the outer half yields a duller sound than the inner, whilst it is less resonant at the sterno-clavicular articulation. The sound over the back and front of the chest is subtympanitic in character, being more or less muffled according to the amount of tissue present, and also the amount of muscular development. For this reason the front and sides of the chest are more resonant than the back; in very thin persons the resonance is increased, whilst in those who are fat and flabby the sound is positively non-resonant. During the long deep expiration which attends coughing or screaming in children, the note on percussion becomes markedly less resonant.

Whilst it is of great importance in percussion to compare

the sound produced on one side of the chest with that on the part symmetrically placed upon the opposite side, it should be borne in mind that on the right and left sides encroachments upon the pulmonary limits take place by the position of the liver on the right and of the heart on the left. The area fixed, theoretically, for the existence of a pulmonary note extends from the apex of the thorax down to the sixth rib in front, the seventh at the sides, and the tenth or eleventh posteriorly. The resonance is greatest from the clavicle downwards to the fourth rib; below this to the edge of the false ribs, the note becomes distinctly less resonant; corresponding to the edge of the false ribs in front, the situation of the intestines gives to the note a distinctly resonant character.

The apices of the lungs extend from three to five centimetres above the clavicles in the supraclavicular regions. In diseases affecting the apices the percussion note shows that the area is lower in point of position during expiration, and that the apex does not expand during inspiration (Seitz).

The lower limit of the *right* lung corresponds to the upper border of the sixth rib in the parasternal and mammillary lines, the upper edge of the eighth rib in the axillary line, the ninth rib in the scapular line, and the tenth rib close to the vertebral column. The lower border of the *left* lung corresponds to the lower border of the sixth rib in the mammillary line, the upper border of the eighth rib, or in the eighth intercostal space in the axillary line, the ninth rib in the scapular line, and the tenth rib close to the vertebral column.

The encroachments of the heart, liver, spleen, &c., upon the pulmonary region will be dealt with when discussing the position of these different signs.

PERCUSSION OF THE CHEST IN DISEASE.

The alterations of the normal percussion note over the lungs may be classified under the heads of—1, diminished resonance; 2, absence of resonance; 3, increased resonance; 4, tympanitic sound; 5, metallic sounds.

1. *Diminished Resonance* (*dulness*).—This is met with in the slight consolidations of the apices which occur in the early stages of phthisis; in pneumonic consolidation; in œdema of the lung, where the serous effusion into the air vesicles *more* than relaxes the pulmonary parenchyma; in *extreme* distension of the lung with air, as in percussing a chest whilst the patient is coughing or holding his breath; in thickening of the pleura with fibroplastic exudation (false membrane). The dulness varies in degree in these different conditions, being described under the names of modified, hard, wooden, &c.

2. *Absence of Resonance.*—Here there is complete toneless-ness, and the attempt to draw any distinctions between the sounds heard that are characterised by this condition cannot be strictly correct. The differences really lie in different degrees of resistance in the parts percussed. The name usually employed to indicate absence of resonance is *absolute dulness.* It occurs in pleural effusion (femoral dulness), or in tumours of the lung or mediastinum (osteal, stony dulness). The dulness in pleural effusion is absolute only when the lung is compressed to a degree beyond relaxation, and it indicates that there is no resonant material behind the effusion. It is of importance to bear in mind that a moderate amount of pleural effusion can exist with a mere muffling of the percussion resonance if the underlying lung be in a condition of relaxation only.

It is well to bear in mind that a resonant note is obtained in the first stage of pneumonia, and also, very commonly, in the stage of resolution. The resonance of the first stage gradually merges into dulness as hepatisation advances, but that of the third stage slowly passes off as the fluid exudation becomes removed from the alveoli and the lung tissue regains its elasticity.

In some cases of pneumonia, a sound which is described under the name of *muffled tympany* is heard over the *hepatised* lung. It is observed most frequently in pneumonia of the upper lobe, though it may be met with in hepatisation of the lower. Its existence over the upper lobe may be assigned to a communicated tubular or tracheal note caused by vibration of the column of air in the trachea and principal bronchus of the lobe, and also to diminished vibrating area. When present over the lower lobe, in which the bronchi are much smaller, it is said to be due to diminished tension in the lung, as well as to diminished vibrating area. The accidental position of a mass of consolidated lung, in relation to a patulous bronchial tube, and in close proximity to the chest wall, may influence the production of the note.

3. *Increased Resonance.*—This is a condition which is met with in marked emaciation of the chest wall, in emphysema, in pneumothorax (where the distension is not extreme), and in conditions where the pulmonary tissue is relaxed and in contact with the chest wall. Relaxation of the lung is most frequently met with in pleural effusion, and the lung is pressed upwards, so that in such cases a resonant note is obtained from the clavicle downwards, often as far as the nipple. This sign is called, after its discoverer, *Skodaic resonance.* It is right to observe that Dr. Bristowe gives good reasons for holding that this increased resonance, instead

of being caused by relaxation of lung tissue, is really due to the vibrating area of the chest being diminished by the effusion. According to this observer, all portions of the thoracic walls which are in contact with the lung vibrate, bell-like, on percussion. The general effect is to produce an assemblage of fundamental and harmonic tones, which will vary in pitch in proportion to the extent of surface which vibrates. If there be any considerable diminution of the vibrating area, as in extensive fluid effusion or pneumonic consolidation, the fundamental note produced will be higher and clearer in pitch in proportion to the diminution which exists.

The hyper-resonant sound obtained frequently in emphysema is sometimes spoken of as the *bandbox sound* (Schachtelton).

4. *Tympanitic Percussion Sound* may be regarded as a degree of hyper-resonance, in which, however, the tone more closely resembles that of a drum, and, in place of being clear, is more or less muffled or dull in character. This condition is sometimes met with over the left infra-mammary region, being conveyed from a distended stomach; it is most marked in cases of retraction of the left lung from disease. Most commonly it exists in pulmonary excavations of large size, situated near the surface, containing air, and communicating with the bronchi. It is also necessary that the cavities should be surrounded by firm walls which are capable of reflecting waves of sound. If a deeply-seated cavity be of large size (larger than that of a pigeon's egg), but connected to the surface by dense solid tissue, the note on percussion over it is tympanitic.

In pneumothorax the sound on percussion varies from that of increased resonance to one either tympanitic in character or amphoric. The variation depends upon the degree of

tension of the pleural sac, and on the existence or non-existence of a communication between the cavity and the external air.

5. *Metallic Sounds.*—The metallic sounds met with upon percussion are the *Cracked-pot sound* and *Amphoric resonance.*

The Cracked-pot Sound (*Bruit de pot fêlé*).—This sound resembles in character the chinking of coins, or the sound produced by laying the palms of the hands on each other crosswise, so as to form a hollow chamber, and then striking the back of one of them against the knee. This sound is developed in a number of conditions, healthy and otherwise. It can be produced on percussion of the chest of a healthy baby when screaming, or in forcibly percussing the chest of adults when singing a long-sustained note. It can sometimes be heard on percussing a chest which is plentifully covered with hair, especially on the front of the chest near the sternum, where it is due to the presence of air in the meshes of the crisp hair covering this situation, which is expelled by the sharp percussion stroke. In disease the cracked-pot sound is met with in the following conditions :—

(*a*) In cavities of moderate size, situated superficially, communicating with a bronchus of medium calibre, and in relation to a part of the chest wall which is yielding. Hence, it is most frequently observed in vomicæ in the upper lobes. Here it seems to be due to the sudden propulsion of air leaving the cavity against the walls of the air passage with which it comes in contact.

(*b*) In pleurisy with effusion the sound can often be produced in the infra-clavicular and mammary regions, above the level of the fluid. Sometimes it is observed in the neighbourhood of pericardial effusion. In both conditions the state of the air vesicles, retracted and approximated to

each other from diminution of their contents, favours the escape of air or percussion.

(*c*) Occasionally in pneumonia, in the relaxed portions of lung which are in the neighbourhood of the part hepatised.

(*d*) In cases of pneumothorax, with an external opening, the air may be made to escape through the aperture by percussing forcibly in its neighbourhood, with cracked-pot sound; very rarely it may co-exist with a bronchial fistula. In *thoracic fistula*, following paracentesis thoracis, it may be frequently observed.

(*e*) In children suffering from bronchitis (Stokes).

This sound is best developed by quick, forcible percussion during expiration, and with the mouth open. A sound almost indistinguishable from it in character was described by Piorry, as produced by percussion over cavities containing both liquid and air; it was termed by him *humoral sound*, and explained as being due to the splashing of the liquid in a cavity. A similar sound can be produced by percussing strongly a bladder containing both air and water a little below the level of the latter.

Amphoric resonance (from *amphora*, a jar) can be best imitated by filliping the cheek when the mouth is closed and fully, but not too tensely, inflated; or by striking the side of an empty cask or pitcher. It is the sound which is heard in certain conditions of distension of the intestines, or over a stomach distended with air. It approaches in character the *tympanitic sound*, but has a distinctly metallic timbre, is higher in pitch, and longer in duration. The amphoric sound consists of a variable fundamental tone (being either clear or muffled), accompanied by overtones or segmental tones; and these overtones, dying away slowly, render the sound longer

in duration than one which is simply tympanitic, and which ceases at once after the percussion stroke.

Amphoric resonance is produced in large caverns filled with air and surrounded by smooth walls which reflect the waves of sound regularly and uniformly. Hence it is observed in pneumothorax and over very large pulmonary cavities. In pneumothorax the sound on percussion is metallic, usually from the onset of the affection, if the tension of the pleural sac be not extreme. It is usual, in such a case, to combine percussion with auscultation, the result being the perception of what is known as the *bell sound* (*bruit d'airain*), which will be described fully in the chapter on Auscultation. The metallic sound in pneumothorax is, usually, only of a transient nature, as when fluid, usually purulent in character, accumulates in the pleura, the sound above it becomes merely hyper-resonant or tympanitic. It should be borne in mind that the metallic sound in pneumothorax undergoes remarkable modifications on changing the position of the patient, and even, independently of this, the sound is frequently, from unknown conditions, variable in its existence.

Amphoric resonance is met with only in large excavations of the lung where the cavity is bounded by smooth, homogeneous walls, containing but little fluid, and in close relation to a resilient superficies. It is heard best when the mouth is open, so as allow the vomica to communicate freely with the external air.

Skoda points out that in certain cases of pneumonia, where there is an unusually rapid, severe, and extensive relaxation of the lung substance, a ringing metallic sound can be produced upon percussion. There appears to be some confusion amongst authorities as to whether this sound is a separate entity, or is really the sound already alluded to under the name of

muffled tympany. There are scarcely any grounds for recognising the distinction: *Entia non sunt multiplicanda præter necessitatem.*

PERCUSSION RESISTANCE.

A second object in percussing the chest, besides determining the character of the sound, is to ascertain the amount of resistance felt by the fingers in percussion. Piorry, who specially devoted attention to the sign, thought it even more valuable than the acoustic sensations of percussion. The more solid the consistence of a body the less is its compressibility, and of course the greater its resistance. More resistance to the soles of the feet is felt in ascending a stone staircase than one made of wood. Hard and incompressible bodies, such as stone, wood, and fluids, are very resistant; soft bodies, such as feathers, cotton, wool, &c., possess almost no resistance; air-containing bodies, a medium amount.

In disease the amount of percussion resistance often enables us to distinguish from each other conditions which give rise to the same note of percussion dulness, whilst it conveys different impressions of the degree of density of parts percussed.

Speaking generally, percussion resistance is *increased* by abnormal conditions of the thorax and soft parts, which offer obstacles to the performance of percussion, such as deformities attended with excessive development of the ribs, narrowness of the intercostal spaces, unusual convexity of the ribs, and the presence of an unusual amount of fat around the mamma, especially in the female.

In affections of the lung it is increased wherever its tissue is impermeable to air, whether that be produced by infiltration, or compression of it by fluid or solid tumours. Three degrees of dulness on percussion with progressive increase of

resistance, representing the progressive diminution of the air-contents of the lung, are sometimes spoken of as the *modified dulness* of pneumonia, the *femoral dulness* of pleural effusion, the *stony dulness* (osteal) of cancer of the lung.

Diminution in resistance is rarely experienced, but it may be found associated with extreme emphysema, or pneumothorax. In the latter a peculiar sensation is sometimes experienced by the finger when the chest is percussed, giving the idea of *undulation*.

Two other conditions met with in percussion may here be noticed—*hydatid fremitus* and *myoidema*.

Hydatid fremitus, or thrill, is a condition which was first described by Briançon, in which, on percussion over an hydatid tumour of the liver, a peculiar thrill is noticed. The mode of eliciting this thrill is to put three fingers of the left hand on the tumour, tap the middle one when the others are felt to be repelled several times by a sort of elastic resistance or fluctuation. The sign was termed by Piorry *frémissement hydatique*. It is one of little value, as it is seldom obtained; and it is not exclusively indicative of the presence of hydatids, as it has been met with in simple cysts, and Skoda has shown that it can be produced in a stomach filled with water, hung up, and percussed.

Myoidema is a peculiar condition which is produced in emaciated persons by *immediate* percussion of certain muscles, especially the pectoralis major. At the part of the muscle struck, a local swelling, knob-like in appearance, is developed, and almost instantly it subsides, wave-like, along the fibres of the muscle. This little tumour is due to *idio-muscular contraction*, which is readily excited when the muscle is in close relation to the skin from absorption of the subcutaneous adipose tissue. This sign was supposed to be peculiar to phthisis, but it is met with in most wasting diseases.

CHAPTER IV.

AUSCULTATION OF THE LUNGS.

Auscultation signifies the act of listening, and as applied to the chest it means the recognition, by the sense of hearing, of the different sounds produced in the organs of respiration in health and disease. It was first discovered by Laennec, who used a roll of paper to hear the beats of the heart in a case of cardiac disease.

Auscultation is employed in two ways—immediate or mediate. Immediate auscultation is the application of the ear directly to the chest. This method has the advantage of permitting us to hear the sounds generated within the chest over a larger area and with a greater degree of loudness than by the mediate method; it is, too, capable of being employed very rapidly—a point to be attended to in cases where the patient is greatly debilitated. The disadvantages of immediate auscultation are the difficulty, or even impossibility, of applying the ear accurately to certain regions of the thorax—the supra-clavicular for example; the difficulty of localising the sounds heard; the disturbance produced by the rubbing of hair in the neighbourhood of the ear; and the objection which exists from considerations of delicacy to the employment of the method in females, or in the examination of persons of dirty habits. It may, however, be employed with advantage over the posterior aspect of the thorax.

Mediate auscultation implies the use of the stethoscope as a medium between the ear and the part under observation. Stethoscopes are of different kinds—either solid rods, or tubes made of wood, metal, or vulcanite; rigid or flexible,

binaural and differential. The binaural consists of a short hollow chest-piece, of a conical shape, attached to which are two flexible tubes, which end in ivory-tipped ear-pieces to fit each meatus. This form of stethoscope has the advantage of being applied in an easy unconstrained position, and without much disturbance to the patient. Theoretically it has the advantage of occupying both ears in the investigation of the sounds under observation, and excluding extraneous sounds. The disadvantages of the binaural are that in all flexible stethoscopes sounds are conducted wholly by the column of air within them, and hence they are likely to be altered (booming) in quality; that sounds produced in the mouth and throat of the patient are apt to be mistaken for pulmonary sounds; that various impulses, recognisable by using the rigid stethoscope, escape attention when using the binaural.

The differential stethoscope is a binaural in which each ear is put in connection with a separate chest-piece. It is employed for the purpose of comparing *simultaneously* the two sides of the chest, or different regions of the heart.

Probably the best form of stethoscope to chose for ordinary use is one made entirely of cedar-wood, the ear-piece slightly hollowed out and fitted with a gutta-percha ring, having a bore of about one quarter of an inch, and the bell, or chest-piece, smooth and flattened, but without sharp edges, and of a diameter of about one and a quarter inches. In applying it care should be taken that the chest-piece should be kept in perfect apposition with the chest wall, with a uniform gentle pressure, and that the ear should be carefully adjusted to the ear-piece so that the meatus corresponds to the end of the tube.

Auscultation of the chest is practised for the purpose of determining the characters of sounds heard (*a*) in breathing;

(*b*) in connection with the voice; (*c*) in connection with the pleura.

BREATH-SOUNDS IN HEALTH.

The sounds heard normally in breathing are the *vesicular* murmur and the *bronchial* murmur.

VESICULAR BREATHING.

Vesicular Breathing.—The vesicular respiratory murmur, or, as it is usually termed, vesicular breathing, is the sound produced at the instant the air-current enters the air vesicles. It occupies the whole time of the respiratory movement, and is, during inspiration, soft, well-defined, and moderately loud. In expiration it is very faint and short in duration, being only a fourth or fifth as long as the inspiratory sound. It may be, even in health, entirely absent in ordinary tranquil breathing, according to Walsh, in one out of every four persons.

Vesicular breathing is heard over the whole of the pulmonary regions, except over those situations where bronchial or tubular breathing is present. It can be best observed immediately under the clavicles, and in the supra-spinous regions. Its acoustic character varies much within healthy limits; it may be almost inaudible, or harsh and exaggerated. Up to the twelfth year this rough form of breathing normally exists, and it is called *puerile*, being probably due to the favourable conditions which exist for the transmission of sound in children owing to the thin chest-wall, and the increased resistance to the passage of air by lungs which are more elastic at earlier than later periods of life.

A form of breathing, known as *jerking inspiration*, is frequently met with, independently of its having any patholo-

gical significance, in persons breathing slowly and irregularly, so that the vesicular murmur is broken up into two or more parts. A *quick, deep* inspiration causes this condition to disappear. Where, however, the air vesicles or minute bronchial tubes in the upper parts of the lungs are partly infiltrated by tubercular deposition, or the bronchial mucous membrane is congested and swollen, this form of breathing is often permanent in character. Sometimes the interruptions occur evenly, three or four in each inspiration, and resemble the sound made by the motion of a cogged wheel.* This is called cogged wheel breathing (*respiration saccadée*). It is a type usually met with in the early stages of tubercular phthisis, and, exceptionally, in irregular or jerky movements of the chest. Where the inspiration lacks uniformity in its character, without being broken, it is termed *wavy*. This is a condition frequently met with in healthy persons.

Occasionally, a variety of wavy breathing is heard over the edges of the lungs, in the neighbourhood of the cardiac region, caused by a sudden rush of air into those parts of the lungs, which rapidly expand, to occupy the space made by the shrinking of the heart in systole. This sound is called the *systolic vesicular* murmur.

Sometimes expansion of the chest takes place before the breath sound is heard. This form is met with in persons free from disease, and is known as *deferred inspiration*. It is most frequently associated with emphysema or laryngeal obstruction.

It may be well here to point out that all respiratory sounds, as well as the voice, are due to modifications of the sound produced by the passage of air through the narrow

* It is found convenient to allude to cogged wheel breathing here, although it is an alteration of the vesicular murmur met with in disease.

glottis. This sound is, of course, modified by resonance in the pharyngeal vault and in the windpipe, and, as it passes downwards, becomes tracheal, bronchial, and vesicular in character. This view as to the cause of vesicular murmur is the one generally accepted, though many high authorities on physical diagnosis, Gairdner amongst the number, believe that the presence or absence of a glottis does not in any way affect its production.

BRONCHIAL BREATHING.

Bronchial respiratory murmur, or *bronchial breathing* as it is shortly called, is the breath-sound which is heard over the trachea, and corresponding to the situation of both bronchial tubes posteriorly. It is heard in its most typical form in the interscapular region, close to the vertebral column and corresponding to the seventh cervical and three upper dorsal vertebræ. The sound heard over the trachea is much louder, harsher, and more hollow than that heard over the bronchi, and it is sometimes termed *tracheal*, to distinguish it from bronchial breathing. As a rule, bronchial breathing is heard best by immediate auscultation, and in some cases a stethoscope with an unusually large bore does not conduct this sound.

ALTERATIONS OF BREATH-SOUNDS IN DISEASE.

Vesicular breathing may be weak, absent, intensified, or replaced by sounds of a different character, such as bronchial breathing or râles.

Vesicular breathing is *weakened* by conditions leading to decrease in the volume of air entering the trachea or bronchi, or by whatever impairs the elasticity of the lungs, so that the air reaches the alveoli only with difficulty, as in

various diseases affecting the larynx, inflammatory thickening of the bronchi, asthenia, emphysema, compression of the air tubes from without. It is *lost* in extreme conditions of the foregoing, but most commonly in large collections of air or fluid in the cavity of the pleura, and in the stage of solidification of pneumonia. Speaking generally, whenever there is collapse, exudation into, or destruction of the alveoli vesicular breathing is absent. In extreme cases of emphysema it may be altogether inaudible.

Vesicular breathing is *intensified* over a lung, or portion of a lung, which is doing compensatory work for deficiency elsewhere. The sound is loud and somewhat harsh, resembling *puerile breathing*, which name, as well as *supplemental breathing*, is given to it. The replacement of vesicular breathing by other sounds will be discussed under the heads of the pathological causes of *bronchial breathing* and *râles.*

The *expiratory murmur* is usually, in health, short, indistinct. and of a soft breezy character. But in disease it may be *prolonged* or rendered *harsh.* Prolongation takes place whenever the elasticity of the lungs is lost, or there is any obstruction to the escape of the respired air. This occurs in severe bronchial catarrh, with tumefaction of the bronchial mucous membrane, especially in the diffuse catarrh which is so often associated with emphysema.

Harshness of expiratory murmur is frequently met with associated with prolongation in bronchial catarrh of a localised character, in one or both apices, when it becomes one of the most valuable signs of commencing phthisis. When accompanied by intensified inspiratory murmur it gives the character of *harshness* to the entire act, which distinguished it from the loud and strong inspiratory sound heard in puerile breathing. The comparison instituted between normal

vesicular breathing and harsh respiration is that the former represents the summer breeze playing in the leafy grove, whilst *harsh* respiration is like the winter's blast coursing through the leafless tree-tops.

Cogged-wheel and jerking breathing have been already referred to (p. 81).

BRONCHIAL BREATHING.

Bronchial respiration, when it is heard in any situation except those indicated, has a pathological significance. It is usually audible during inspiration and expiration, being louder during the latter act. It is a harsh rough murmur, which may be imitated by blowing through the tube of the stethoscope. It is met with in three conditions affecting the vesicular structure of the lungs—(1), in collapse of the air vesicles or exudation into them, as in the different forms of pulmonary collapse, pneumonic, phthisical, or caseous infiltration; (2), in destruction of the vesicular structure and its replacement by pulmonary caverns, with rigid and dense walls, which are capable of considerable reverberation—in vomicæ near the surface, connected with a large or dilated bronchus, the sound is markedly present; (3), in condensation of the lung, the result of compression, as in pleural effusion, or rarely, in pneumothorax. In pleural effusion the bronchial sound transmitted from the trachea is usually heard posteriorly, where the shrunken lung lies closely pressed against the chest wall, along the vertebral groove.

The physical cause of pathological bronchial respiration is that the laryngeal or glottic sound is carried downwards and conveyed to the surface with almost undiminished intensity by the consolidated or condensed lung tissue, while there is no vesicular breathing to cloak it.

Varieties or modifications of bronchial breathing are met

with and described under the names of *tubular*, *cavernous*, and *amphoric* respiration.

Tubular breathing is bronchial breathing with a peculiar whiffing and brassy character, and it is met with in its most marked form only in pneumonic consolidation. It is a diffused blowing sound which represents bronchial breathing in an exaggerated degree.

Cavernous respiration is a form of breathing which possesses the hollow quality of bronchial breathing in a high degree. Its term almost explains its nature—air passing into a hollow space. It is generally met with in cavities of large size situated near the surface, surrounded by condensed lung tissue, usually empty of fluid contents, and communicating freely with one or more bronchi. It may also be present in marked dilatation of the bronchi (*bronchiectasis*).

A variety of cavernous breathing was described by Laennec under the name of the "veiled puff" (soufflé voilé), in which a "sort of movable veil, interposed between an excavation and the ear," seemed to be agitated to and fro. This phenomenon, however, is so rare that Walsh met with it in only one instance. But a form of "veiled puff" described by Skoda is not uncommon. Here the respiratory murmur, which at an early stage is quite inaudible, becomes suddenly bronchial or tubular as respiration advances; or, as Skoda describes it, it is identical acoustically with the sound produced by placing the mouth in the position to pronounce the guttural *ch* (as in *ch*oir and *Ch*ristian), and drawing the breath to and fro.

Amphoric respiratory murmur is bronchial breathing accompanied by a tone of metallic quality, which is sometimes associated with metallic tinkling. The amphoric character may accompany either inspiration, or expiration, or both, and

is usually best heard during expiration. It owes its name to its resemblance in acoustic character to the sound produced by blowing over the mouth of an *amphora* or jar. It is met with in its typical form in pneumothorax, when the lung is still able to expand so far as to admit the entrance of a certain quantity of air. It is found rarely in pulmonary excavation, where the cavity reaches the size of the closed fist, freely communicates with the bronchi, is situated close to the surface of the lungs, and surrounded by walls of uniform density. The metallic note partakes of the character of an echo, having frequently several tones recognisable in it, and giving one an impression like that produced by the motion of the wind upon the strings of an Æolian harp.

Indeterminate respiratory murmur.—Sounds heard over the chest, which partake of the characters of neither vesicular nor bronchial breathing, are described under the name of indeterminate respiratory murmur. A good idea of the qualities of this murmur may be obtained by getting a strong healthy adult to breathe superficially, and then listening over the parts of the chest where there is prominent muscular development, as in the supra- and infra-spinous regions; or to auscultate the respiratory murmur at some point distant from the site where it originates, as by passing the stethoscope from the borders of the lung downwards over the hepatic region. It is a simple matter of practice to get familiarised with the character of sounds "somewhat vesicular," "faintly bronchial," &c. It is of great importance that these sounds should be recognised, for whilst in health they may be found in symmetrical sites over both sides of the chest, in disease their general, unilateral, or localised distribution, and their frequent association with adventitious sounds render them

of value in diagnosis. The condition with which *indeterminate breathing* may be said generally to be associated is insufficient expansion of the alveolar structure of the lung, the most common causes of which are emphysema, partial compression of the lung by air or fluid, and obstruction of one or more of the bronchial tubes in connection with an infiltrated portion of lung. The obstruction in the bronchi is caused by profuse secretion of viscid mucus, which is readily displaced by coughing, so the indeterminate quality of the respiratory sound may be only a temporary condition. Indeterminate respiratory murmur heard under *one* clavicle is a valuable early sign of tubercular infiltration. It may occur alone, but it is usually accompanied by râles.

Râles.—The term "râle" originally applied to the death-rattle—*le râle de la mort*—was extended by Laennec to all *adventitious* sounds produced by impediment to the entry or escape of air within the lungs or bronchial tubes. It is also called *rhonchus or rattle.* It is heard during inspiration or expiration, or during both. It may be developed in the large or small bronchial tubes, when the râle will be *coarse* or *fine*, associated with dry or humid conditions of the bronchi, when it is said to be *dry* or *moist.*

The varieties of râle which are met with may be classified as follows:—

(*a.*) Sonorous or sibilant—Stridor.
(*b.*) Crepitant râle, or fine dry crepitation.
(*c.*) Mucous râle.
(*d.*) Doubtful or indeterminate râles.

(*a.*) Sonorous or sibilant râle—Stridor.—The sonorous or sibilant râle is spoken of as being snoring, cooing, or whistling in character. It is heard during inspiration and expiration, completely masks the respiratory sound, and resembles

in quality the sound made in the large and small pipes of an organ (organ-pipe râles). When developed in the large tubes the râle is sonorous, in the small tubes sibilant; the difference between the two being mainly one of pitch. The râle is developed whenever the large or small bronchial tubes are narrowed either by swollen mucous membrane, collections of mucus forming imperfect plugs which readily vibrate, spasmodic contraction of medium-sized tubes, and pressure and constriction of the bronchi from disease external to it. It is most commonly associated with bronchial catarrh and asthma, and is *dry* in character. As the conditions under which it is developed may be readily removable, so the râle may be a transient one, being often removed by coughing. Even in health a few faintly-marked râles of a sonoro-sibilant nature may be occasionally heard scattered over different portions of the lungs during a sudden and forcible inspiration. They are lost during the succeeding inspiration.

Stridor (called in German, *Stenosengeräusch*) is a variety of sonorous râle which is produced by the pressure of a tumour upon the trachea or main bronchi, or in affections of the larynx involving spasm, œdema of the glottis, paralysis of the vocal cords, &c. It is a coarse vibrating sound, which can usually be heard without auscultation, and which, on examination of the chest, can be recognised as having a distant origin.

(*b.*) Crepitant râle or fine dry crepitation.—This is the finest of all râles met with, and is compared to the sound produced by rubbing a lock of hair between the fingers close to the ear (Williams), or to crackling of salt thrown upon the hot plate of a stove. It is a râle with which we are familiar as the typical sign of the first stage of pneumonia (engorgement); it is heard during inspiration only, and mainly at the end of the act. Here it is due to the abrupt separation of the walls of the

alveoli, which are collapsed and perhaps adherent. Wintrich was able to produce in the dead body a sound resembling this râle by inflating the collapsed lungs, the walls of the alveoli being in contact. That such a condition could produce the sound may be illustrated by separating suddenly two fingers previously gummed together by their palmar surfaces, or by applying the tongue to the roof of the mouth and then rapidly detaching it.

This râle may be met with in other conditions, and may also be heard during the whole of inspiration and occasionally during expiration as well. The conditions referred to are—œdema of the lung, especially that met with in Bright's disease, and pulmonary collapse. It may be observed sometimes at the bases of the lungs of persons who are suffering from an acute illness (fevers of various kinds), and who have lain for a long time on the back. When put sitting up in bed a very fine crepitant râle may be observed over the infra-scapular regions. The râles disappear after a forcible inspiration or a cough; this condition is known as the *crepitus of decubitus.*

A râle which closely resembles the crepitant râle, but which is recognisable as not so *dry* in character, is the *sub-crepitant* or *muco-crepitant* râle. It is produced by the passage of air into the thin fluid which is poured out into the minute bronchioles and alveoli. It is met with in the resolution stage of pneumonia, in catarrhal pneumonia, and in pneumonic phthisis. It is also met with in the early stage of pleurisy from a condition of concurrent pulmonary œdema (the subpleural crepitant râle).

(*c.*) Mucous râle.—This is a bubbling râle which resembles acoustically the sound made by the bursting of soap-bubbles in water, or of the bubbles which reach the surface of water

beginning to boil. The size of the bursting bubbles is determined by the quantity of fluid present in the bronchi, and the strength of the current passing through it; and by the lumen of the bronchi in which the râles are developed. Hence we speak of fine bubbling, coarse bubbling, and medium-sized bubbling râles. These râles always indicate the presence of fluid in the air passages, and they are the ordinary signs of bronchial catarrh. They may be clicking in character, especially in the catarrh which ushers in tubercular phthisis, where the fluid poured out is thin, and so likewise are the walls of the air-bells which burst with a sharper sound than that heard in the ordinary mucous râle. Where there is much reverberation, as in large-sized phthisical cavities, the mucous râle acquires a *cavernous* character.

(*d.*) Doubtful or indeterminate râles.—The râles which do not come under any of the foregoing heads and which partake more or less of a hybrid character, are—*creaking sounds*, the *dry crepitant râle* (Laennec), and *metallic râles.*

The *creaking* râle, or dry crackling sound, is frequently heard at the apices of the lungs in phthisis, and appears to be caused by pleuritic adhesions and conditions of disease in the superficial parts of the lung.

The *dry crepitant* râle, with great bubbles, is a sound compared by Laennec to that produced by inflating a dried bladder; it is due to the distension of the enlarged air-sacs of an emphysematous lung.

The *metallic râles* are two in number—*metallic tinkling* and the *bell sound.*

Metallic tinkling is a term applied to a clear, ringing, highly-metallic single sound of low pitch, like that produced by striking a hollow glass of globular form with the head of a pin. It is usually associated with amphoric respiration,

following (echo-like) inspiration, and being prolonged into the succeeding expiration. Most probably *metallic* tinkling is produced by the bursting of large bubbles in large, air-filled cavities, with smooth walls, and containing fluid which is capable of being agitated. The morbid states in which the sign has been observed are pneumothorax, pyopneumothorax, and large-sized excavations in the lung.

The bell sound (*Bruit d'airain*).—This sound is one which has the advantage of being under the control of the observer, unlike metallic tinkling, which is capricious in its development. It is an extremely well-marked, metallic echo, heard by applying the ear to the chest, over a large air-containing cavity, as in pneumothorax, whilst an assistant strikes the surface with a hammer on a metallic pleximeter, or—what suits admirably—one coin upon another. The sound produced is distinctly musical in character, and not unlike the chime of a clock.

AUSCULTATION IN CONNECTION WITH THE VOICE.

On listening over the chest of a person whilst he speaks, the sound of the voice is found to be transmitted in a diffused and indistinct degree, as if he were speaking through a trumpet. This sound is termed the *vocal resonance.* The sound is best heard by immediate auscultation, and varies greatly in intensity and character in different regions of the thorax. In the interscapular regions, over the situation of the main bronchi—especially that of the right from its larger size and direction—the sound is often somewhat clear in character, approaching in degree the voice-sound heard upon listening over the trachea. This clear vocal resonance is termed *bronchophony.* Over the remaining part of the chest, and frequently over its entirety in many persons, the

voice has a peculiar, indistinct humming or buzzing noise, which forms a contrast to bronchophony; this is called *muffled vocal resonance.* The degree of vocal resonance depends upon the pitch and quality of the voice, being more marked with a deep than with a high voice; hence it is least marked in women and children.

The cause of vocal resonance involves an examination of the voice itself, and the way in which it reaches the surface of the chest. The voice is caused by the vibrations of two elastic membranes—the vocal cords—produced by a current of air directed against them during a more or less prolonged expiratory movement. The vibrations of the cords are imparted to the column of air above them in the pharynx and mouth. These parts being capable of changing their shape constitute a resonance-tube for the modification of the sounds generated in the larynx, and so articulate speech is produced. The larynx may be regarded as a reed instrument with a fundamental tone, the loudness, pitch, and quality of which depend respectively upon the strength of the expiratory current of air, the length and tension of the vocal cords, and the number and character of the overtones accompanying the fundamental note sounded. The addition to the fundamental note of the various minor or segmental tones and over-tones, caused by the different changes occurring in the mouth, explains articulation.

The way in which the voice reaches the surface of the chest may be explained thus:—The sounds of the voice, which, we have seen, are made up of sonorous undulations generated by the vocal cords and modified by the parts above them, are conducted upwards and downwards. In passing downwards the trachea plays the part of a speaking-trumpet. The inner surface prevents the diffusion of the vocal vibra-

tions by reflecting them, so that they are confined within the tube and carried downwards in all their fulness. Two circumstances, however, render their perception far less distinct than the sounds heard in the mouth — first, that the current of air which conducts them is in a reverse direction to that which propagates them; and, secondly, that the articulated tones have to pass through the narrow aperture between the chordæ vocales. Beyond the bifurcation of the trachea we find conditions unfavourable to the conduction of vocal vibrations to the surface of the chest. The lungs are, no doubt, kept in a condition of openness, or distension, so that vibrations can be carried along the air columns which fill the bronchial tubes; but the progressive division of these tubes, their enormous number, the fact that their total sectional area is so very much greater than the parent trunk, render the conduction of these vibrations progressively weaker and weaker, so that ultimately, as they reach the surface, they are, in a great degree, lost, hence the sounds of the voice are heard weak and muffled.

The normal bronchophony of the large tubes is effaced by the vesicular vocal resonance (muffled tone), because the pulmonary tissue in its healthy condition, representing alternations of air and membrane, is a *bad* conductor of sound. The physical cause of bronchophony when produced in disease depends upon the fact that *impermeable* lung tissue is a *good* conductor of sound.

In testing the vocal resonance it is well, in some cases, as in palpation, to get the patient to cough before he speaks, so as to clear the bronchial tubes of large plugs of mucus; to have him speak slowly and in as low a tone as possible; and to employ certain uniform words or numbers ("nine hundred and ninety-nine"), so that accurate comparison may be made of different regions of the chest.

ALTERATIONS OF VOCAL RESONANCE IN DISEASE.

The principal alterations of vocal resonance in disease may be classed under three heads :—

(*a*) Where it is diminished or lost.
(*b*) Increased.
(*c*) Altered in quality.

(*a*) It is *diminished* or *lost* in conditions which separate the lung from contact with the chest-wall, as in pleural effusion, great pleuritic thickening, or pneumothorax; in diseases which occlude the main bronchi in connection with the part auscultated, as in tumours pressing upon it, plugging with muco-pus, &c.; in emphysema, where there is great rarefication of the lung, the voice sound is greatly enfeebled.

(*b*) It is *increased* whenever there is solidification of the lung with a patulous condition of the air-tubes, and the term given to the intensified sound is *Bronchophony*. The most common conditions with which bronchophony is associated are pneumonic or tubercular consolidations of the lung, or the existence in the lung of a large cavity surrounded by dense walls. It is also met with in the consolidation produced by collapse, hæmorrhagic infarction, and in induration of the lung (fibroid phthisis).

(*c*) The *alteration* in quality of the vocal resonance may be described under the heads of *Pectoriloquy*, *Ægophony*, and *Autophony*.

PECTORILOQUY.

Pectoriloquy was a sign described by Laennec, the features of which are that the sound of the voice appears to come directly through the bore of the stethoscope, that is, as if the words uttered were spoken directly into the ear of the observer, with

sometimes painful distinctness. It may be regarded as a greatly increased form of bronchophony, in which not only the *noise* of the voice is heard, but the sounds are most distinctly *articulated.* It is heard only over a limited area, and was regarded by Laennec as pathognomonic of a cavity in the lung, with free communication with a bronchus. It is, however, met with in pneumonic consolidations in immediate proximity to a large bronchus, and in some cases of tumours lying between the main bronchi and the parietes.

A sharp distinction is drawn by some authorities between pectoriloquy and bronchophony. Bronchophony is held to represent the conduction downwards of the vibrations of sound produced in the larynx, whilst pectoriloquy represents those vibrations which are developed in the mouth, and which form articulate speech. Hence, pectoriloquy will be best heard during a whisper, when the aperture between the cords is widened out, and so the transmission of articulate sounds is facilitated; whilst in loud speaking the portal of the larynx being almost closed, their transmission is obstructed and they are rendered almost inaudible (Bristowe).

ÆGOPHONY.

Ægophony is a modified form of bronchophony, in which the sound produced is of a tremulous, nasal character, resembling the bleating of a goat, or the squeaking voice of *Punch* in the exhibition of *Punch and Judy.* It is heard best by immediate auscultation, and usually about the inferior angle of the scapula, and round towards the axilla. It is generally met with in pleurisy, where there is a thin layer of fluid between the lung and chest-walls, but it has also been occasionally observed in large pleural effusions; the bronchophony of pneumonic consolidation may occasionally

be made ægophonic by making the patient speak with the nostrils closed.

Various theories have been offered with regard to the mechanism of ægophony, that of Dr. Stone being the most acceptable one, as it also explains loss of tactile vibration in pleural effusion. When the pleura contains a small amount of fluid the waves of the fundamental tone are intercepted, that is, those waves which are heard under normal circumstances, whilst the finer and closer undulations of the high harmonics are allowed to pass to the surface. When, however, the effusion is large, all tones are usually cut off, the harmonic over-tones as well as the fundamental tone.

AUTOPHONY.

The term autophony is applied to an intensification of the voice of the auscultator whilst listening over a superficial cavity which is surrounded by condensed lung-tissue. It is a sign of little clinical value.

AUSCULTATION IN CONNECTION WITH THE PLEURA.

When the two surfaces of the pleura are inflamed, and lymph is poured out upon them during the respiratory movements, a sound is developed by the rubbing of one surface upon the other, which is called a *friction sound.* The sound varies in intensity from that of the lightest rubbing to one of a harsh, scraping character. It is sometimes moist or spongy in character, resembling the crepitation of a moist sponge, and being almost indistinguishable acoustically from fine moist crepitation. This sound is probably due to separation of the two surfaces of the pleura rendered adherent by recent moist lymph of a pasty character, as in pleuro-pneumonia. It accompanies inspiration, or expiration, or both; it may occupy only a small part

of either act. In rare cases it may be heard only during the respiratory pause, as if the roughened surfaces had caught at the end of expiration, and then, owing to their elasticity, had freed themselves.

The friction sound of pleurisy is usually heard over the lower half of the chest below the axilla, extending forwards towards the breast or about the inferior angle of the scapula. It is usually insulated in position, and unattended by any other morbid sound. Sometimes, however, the inflammation of the visceral layer of the pleura gives rise to œdema of the subjacent part of the lung, in which case the friction sound may be accompanied by a *subpleural crepitant-râle.* Friction sound is not influenced by cough, but it is often intensified by the pressure of the stethoscope, which brings the two inflamed surfaces into closer apposition. It is to some extent modified by position, and, as before alluded to, it is often appreciable by palpation.

A variety of friction sound is occasionally heard over those portions of the pleura which overlap the heart. The motion of the latter against the inflamed pleura produces a sound which closely simulates that developed in the dry stage of pericarditis, the *cardiac pleural friction sound.* The stoppage of respiration usually causes cessation of the abnormal sound, whilst the progress of the case demonstrates the ordinary conditions of pleuritic inflammation.

The causes of a pleural friction sound are exuded lymph or organised false membranes upon the pleural surfaces, miliary tuberculosis involving the surfaces of the lung, and, it is said, mere extra-vascularity of the pleura. Laennec described the occurrence of friction sound as a sign of interlobular emphysema.

In connection with friction sounds, developed in pleurisy,

it is well to allude briefly to certain sounds, extra-pulmonary in origin, which may simulate those developed in the pleura. They are tabulated by Dr. Gee under four heads :—

1. Peritoneal friction, heard over the hepatic region, and produced between the liver and the diaphragm.

2. Shoulder-joint friction, a dry rubbing sound, heard in the supra-spinous fossa, though produced in the shoulder-joint. The sound is mostly inspiratory, and is heard with increasing intensity as the shoulder-joint is approached.

3. Shoulder-blade friction is sometimes caused by the movement of the scapula against the ribs.

4. Muscular rumbling of a continuous character is often heard during auscultation, but is scarcely likely, from its peculiar character, to be confounded with a friction sound.

SUCCUSSION.

In connection with abnormal sounds developed in disease of the pleura, succussion sound may be noticed. This sound may be regarded as one of the most venerable of the physical signs of lung disease, having been described by Hippocrates, after whom it is named Hippocratic Succussion. If a large cavity contains both *air and fluid*, as in hydro-pneumothorax, and the patient is shaken or shakes himself, a splashing sound is heard, which may be audible to the patient himself. The movement usually employed to develop the succussion sound is to push the patient's body abruptly but gently backwards and forwards, whilst the observer's ear is applied to the chest; or the patient may sway his trunk quickly from side to side. The sound is produced by the abrupt collision of air and liquid in a unison-resounding or echoing space of large dimensions.

AUSCULTATION OF THE COUGH.

Auscultation of the cough does not need comment. As an adjuvant to auscultation cough acts in four ways:—

1. It makes the inspiratory murmur more distinct when repeated a number of times.

2. It removes obstruction in the bronchi by the expectoration of plugs of mucus from them.

3. It often develops râles, which, during ordinary respiratory acts, were inaudible. This is especially observed in the early stage of tubercular deposition.

4. It brings out forcibly the ringing character of the metallic râle which may not be audible during inspiration.

CHAPTER V.

EXAMINATION OF THE SPUTUM.

THE matter which is expelled from the chest by *coughing* is called sputum, phlegm, spit, or expectoration; that from the nasal passages, mouth, or pharynx is got rid of by *hawking.*

In ordinary conditions the small bronchial tubes are kept free from obstruction by the movement of the ciliated epithelium which lines their walls. The large tubes, being much smaller in area than the combined area of their branches, have their passages kept free, and accumulations removed, by the forcible entrance and exit of the air through them during ordinary expiration. A forcible act, such as that involved in coughing, with closure of the glottis, clears the tubes from any collections which may happen to be lying in them. In states of extreme debility where there is great muscular weakness, or where there is a great diminution in the elasticity of the lungs, as in emphysema, the sputum cannot be expelled; it accumulates in the tubes, and in this way becomes the immediate cause of death. To this condition the name of *suffocative catarrh* is given.

Before proceeding to discuss the composition and varieties of sputa, it may be well to dwell briefly upon some points in connection with the act by means of which it is eliminated—viz., cough.

COUGH.

Cough is a violent expiratory act, after a forcible inspiration, in which the glottis, at first closed, is violently opened with a loud sound, caused by the blast of air passing from the lungs.

It is produced by irritation of the sensory nerve of the larynx—the superior laryngeal. The irritation may be transmitted either from the distribution of the vagus nerve in the throat, larynx, bronchial mucous membrane, or stomach; or it may be reflected from other nerves to the cough-centre in the floor of the fourth ventricle. Kohts, from experimental observations, found that he could produce cough in animals by mechanical or electrical stimulation of a part of the floor of this ventricle, immediately above the respiratory centre. It is, probably, by excitation of this centre that cough is produced in affections of the ear (Fox) and teeth, and in hysteria. Dr. Hilton-Fagge classifies cough according to the situation of the irritation which produces it, into—

1. Throat cough.
2. Ear cough.
3. Tooth cough.
4. Stomach cough.
5. Centric cough.

1. Throat cough is very frequently associated with catarrh of the fauces, and especially where there is any irritation involving the glosso- and arytæno-epiglottic folds or the lateral edges of the epiglottis. A distressing tickling cough is often produced by an elongated and swollen uvula coming in contact with the parts lying at the base of the tongue.

2. Ear cough is not uncommonly found to be associated with irritation of the external auditory meatus. Probably the irritation is conveyed to the nerve-centre by the auriculo-temporal branch of the fifth nerve.

3. Tooth cough has been shown to be associated with disease in the stump of a tooth, and in infants it is met with during the first dentition, prior to the eruption of the teeth.

4. Stomach cough.—The occurrence of stomach cough,

although laid much stress upon by the older writers, is a matter which is involved in doubt. Most cases recorded of cough referred to the stomach are instances of irritation in the upper air-passages of so marked a character that the efforts produced by violent and persistent coughing have resulted in vomiting, which assisted materially in expelling foreign matters from the bronchi, and so, for a time, removed the cough. Kohts failed altogether to excite cough by irritating the stomach, and he is not disposed to admit its causation by gastric derangement. Dr. Walsh, however, mentions that he has known a very persistent cough, lasting several weeks, to be produced by the presence of an *ascaris lumbricoides*.

5. Centric cough.—Reference has already been made to Kohts' experiments with reference to a cough centre in the medulla oblongata. Various forms of nervous cough—notably that occurring in hysteria—owe, probably, their origin to disturbance of a centric nature.

Cough varies much, in different cases, in its frequency, character, and in its mode of termination if paroxysmal. It is sometimes constant, not being interrupted by intervals of repose—as in some cases of heart disease, and in the early stage of acute catarrhal phthisis. In character it may be *dry*, as in pleurisy and the first stage of tubercular phthisis; or *moist*, as in the second stage of bronchitis, and the late stages of phthisis. It is often painful, as in pleurisy, pleurodynia, and pleuro-pneumonia; brassy in character, as in aneurysm, from pressure on the recurrent laryngeal nerve (*tussis clangosa*); stridulous, hoarse, or croupy, in croup or laryngeal irritation. It may be distinctly paroxysmal in whooping-cough and in certain forms of bronchitis, the paroxysm being often terminated by an act of vomiting. It may be loud, barking, constant, and dry in hysteria.

SPUTUM.

Healthy secretion from the air tubes consists of a transparent colorless fluid, slightly glutinous like thin mucilage, and containing mucus, a varying quantity of saline matter, and water. This is the secretion which, increased in quantity and viscidity, is found in an ordinary bronchial catarrh.

Mucus (Mucin) being secreted by the bronchial mucous membrane is found in every variety of sputum, but in very varying quantity. It is ordinarily fluid, but at other times extremely viscid in character, so as to be capable of being drawn from the expectoration cup in transparent ropes or threads. Its presence is tested by the addition of acetic acid to the fluid supposed to contain it; a cloud or precipitate is formed by the acid if mucus be present.

Saline matter is found in large quantity in transparent viscid expectoration; in much smaller quantity in the opaque and less tenacious kind, whilst it is almost absent in purulent sputum.

Water forms a considerable part of all sputa, and upon its amount depends the fluidity of the expectoration. It is derived from the mucous membrane of the mouth and bronchial tubes, as well as from the pulmonary alveoli (œdema of the lungs).

Albumen is very often present in sputum from the fact that blood, pus, &c., frequently form some of its constituent elements. It is met with in greatest quantity in pneumonia, in which a plastic exudation containing blood is found in the pulmonary parenchyma.

Various figurate or morphological elements have been found in sputum which may be classified under the heads of—(1) epithelium; (2) pus corpuscles; (3) red corpuscles; (4) fibrinous

coagula; (5) crystals; (6) foreign particles; (7) *débris* of lung tissues—elastic fibres; (8) parasitic growths.

1. *Epithelium.*—Pavement, columnar and columnar ciliated epithelia are met with in sputum; the first being derived from the upper part of the air passages, chiefly the buccal mucous membrane; columnar and columnar ciliated epithelia are also derived from the air passages—from the larynx downwards to the finest arterioles. Whilst pavement epithelium is very constantly found in sputum, the other varieties are present, but rarely, owing to the very intimate attachment which the cells have to the basement membrane. Friedländer points out that alveolar epithelial cells are not met with in sputum in their normal flattened condition, but in a swollen spherical form from their being brought in contact with fluid, or undergoing some inflammatory change. These rounded cells, which are abundantly met with in the sputum of pneumonia, are in diameter about two, three, or four times greater than that of a white blood-corpuscle, contain granular masses of protoplasm, and one or more large oval nuclei, with nucleoli. They are peculiar in the ready way in which they become pigmented, and in their tendency to undergo fatty and myelin degeneration. Alveolar epithelium is found in the sputa, not alone in pneumonia, but in many other affections of the respiratory organs, as in œdema of the lungs, hypostatic congestion, hæmorrhagic infarction, and almost all forms of phthisis. In commencing tubercular catarrh of the apex, it may be found in considerable quantity in the sputum, before any other physical sign is developed; it thus affords a very important and early diagnostic indication of the disease.*

2. *Pus Corpuscles.*—These are white blood corpuscles which

* "Ueber Lungenentzündung nebst Bemerkungen über das normale Lungen-Epithel." Berlin, 1873.

make their way through the walls of the capillaries in inflammation (Cohnheim), and are present in such varying numbers as to give to the sputum certain microscopic characters; it being sometimes white, yellowish white, or yellow in colour, more or less viscid and opaque.

3. *Red Blood Corpuscles.*—Blood in the sputum may be in such quantity as to give it a rusty or blood-stained tinge, or it may be expectorated in such amount as to be free from all extraneous ingredients. Its presence in even the smallest quantity may be determined by the microscope. Unless blood be mixed in the expectoration with a large quantity of water the red cells present their normal appearance.

Blood makes its appearance as streaks mixed with mucoid or purulent sputum, in the pure state, or frothy from admixture with air, and of a bright florid colour. These conditions are frequently observed in pulmonary phthisis.

It is intimately mixed with the frothy mucus of pneumonia, having undergone such a change after its exudation as to impart to the sputum a tint of a bright orange or iron-rust colour.

In heart disease blood is expectorated pure where there are engorgement and rupture of the pulmonary capillaries. In embolic plugging of the pulmonary vessels (hæmorrhagic infarction) the blood expectorated is of a dark colour, clotted, and mixed with a considerable quantity of mucus.

There are four points which are relied on in distinguishing pulmonary hæmorrhage from hæmatemesis (vomiting of blood). Blood effused into the lungs is *coughed up;* it is usually of a *bright red colour; it is fluid* and *frothy*, from being mixed with air. Blood from the stomach is *vomited;* it is usually of a dark *reddish brown* or *chocolate-brown colour*, closely resembling coffee grounds; and frequently where it has been

retained for a time in the stomach, it forms *clots* which are expelled mixed with food *débris.*

It is well, however, to bear in mind that blood, under exceptional circumstances, may be retained a long time in dilated bronchi or in vomicæ, and be expelled, dark in colour and coagulated. On the other hand, if blood be poured out quickly into the stomach, and in large quantity, it may be vomited unaltered in appearance.

Blood trickling downwards from the mouth, nose, or pharynx, may pass into the larynx and bronchi, become bright in colour from admixture with air, and be expectorated as if it came originally from the lungs; or blood poured from the nose, mouth, or lungs may trickle down the pharynx and œsophagus and enter the stomach, from which it is ejected by vomiting.

4. *Fibrinous coagula* were described centuries ago under the name of *Bronchial Polypi.* They are met with in croupous or plastic bronchitis, and represent dichotomous casts of the bronchial tree, sometimes extending down to its finest subdivisions, so that the terminal filaments of the casts present bulbous expansions which are moulded in the infundibula (Biermer). The coagulum usually presents itself in the form of a ball rolled up immersed in mucus and, generally, a profuse discharge of blood. When washed free of its surroundings the clot is observed to be of a whitish-yellow or grey colour, made up of lamina, placed concentrically, separated here and there by narrow spaces filled with air, and having a central cavity. Dr. Walsh specially points to the laminated structure of the coagulum, as forming a contrast to the coagula, formed of blood, which are formed in the air-passages as a result of hæmorrhage.

The length of a bronchial cast varies from one and a-half to three, four, or even six or seven inches, as in a case recorded

by Riegel. The diameter depends upon the size of the tube in which it is found, being scarcely ever greater than that of a goose-quill. Its appearance often affords an indication of the portion of the lung in which it is formed, being short and rapidly branching if from the upper lobe, much longer and less branched if from the lower (Biermer).

Microscopically the casts consist of a hyaline base largely interspersed with leucocytes. Occasionally Charcot's crystals have been found in them.

Minute coagula are frequently found in the sputum of croupous pneumonia occurring in adults from the beginning to the acme of hepatisation. They are absent from the sputum of catarrhal and of interstitial pneumonia.

5. *Crystals.*—Crystals of the fatty acids, palmitic and stearic, in combination, are those which are most frequently found in the sputum. Microscopically, with a magnifying power of 300 diameters, they present the appearance of long, slender acicular needles, colourless, and usually straight, but sometimes sharply bent, twisted, or varicose. The varicose appearance, Traube shows, is due to pressure by the cover-glass. They may occur singly or in tufts or sheaves, and are generally mixed up with finely granular *débris* and fat globules, so as to form soft, friable, smooth masses of a size varying from that of a millet seed to a bean, of a dirty greyish-yellow colour, and having an extremely fœtid odour. These masses, known as "Dittrich's" or "Traube's" plugs, are found in the sputum of fœtid or putrid bronchitis—conditions where the purulent expectoration is retained in the dilated bronchi (bronchiectasis), and undergoes putrefactive decomposition. Leyden and Jaffé have succeeded in producing a similar putrefactive process in muco-purulent sputum outside the body, and they point out

that the source of the vegetable organisms found in it is the *Lepthothrix buccalis*.

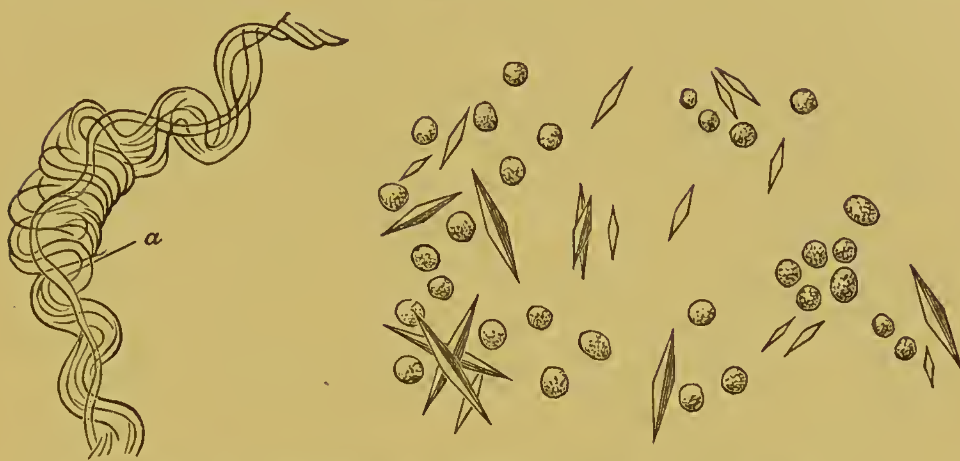
Fig. 18.

Crystal of Fat Acids.

Another variety of microscopic crystals has been found in sputum, and (in leukæmia) in the spleen, the blood, and the marrow of the bones. They were first described by Charcot, and are known as Charcot's crystals. They occur as elongated, pointed octahedra, as rhombic plates, or in fine, sharp, spindle-shaped bodies. They are colourless, of organic origin, but obscure as regards their chemical nature. They may be preserved in spirit, as they are insoluble in alcohol, but are rapidly dissolved in concentrated acids and alkalies. They are found in the sputa of chronic bronchial catarrh, in emphysema, in croup, and most frequently in bronchial asthma, especially during and immediately after the spasmodic seizure. Leyden held that the paroxysm of asthma was produced by the crystals irritating the peripheral ends of the branches of the vagi in the bronchial mucous membrane, and so setting up a reflex spasm of the muscular fibres beneath. The crystals, when met with in the expectoration of asthma, are frequently associated with peculiar spiral-shaped bodies, described specially by Curschmann, which

represent casts of the minute bronchioles; they are known as Curschmann's *spirals*.

Fig. 19.



Asthma crystals and Curschmann's spirals (*a*, centre fibre).

Crystals of *hæmatoidin* have been met with in the sputum in cases of bronchiectasis, empyema, and where an hepatic abscess has opened into the bronchi; crystals of *cholesterin* in cases of pulmonary abscess or empyema penetrating the lung; and crystals of *tyrosin* occasionally in fœtid bronchitis.

8. *Foreign Particles.*—The foreign particles which may enter the lungs and be present in sputum are *carbon*, from coal, charcoal, soot, or smoke; *oxide of iron; quartz, sandstone, or clay; cotton and flax.*

Carbon.—In labourers in coal-mines, or in those engaged in manufacturing charcoal, a form of *spurious melanosis* may be occasionally observed in the lungs, which are found to be everywhere of a black colour, exuding on pressure a black frothy fluid, which stains the fingers like Indian ink (*miner's lung, Anthracosis*). The general anthracosis of the lungs is explained by the facility with which the leucocytes take up particles of carbon, and permeate animal membranes or tissues

in all directions. In cases of phthisis associated with anthracosis, "black spit" is often expectorated in considerable quantities.

Oxide of Iron.—Workers in red sandstone quarries have their lungs reddened by inhalations of particles of oxide of iron, which permeate the lungs, and give them an appearance as if they had been daubed over with red paint (*Siderosis*). Zenker has published the notes of a case of this discoloration occurring in a woman whose occupation was to make the little paper books in which gold leaf is laid. The paper has to be stained red with peroxide of iron, which is rubbed in by a piece of felt. The occupation is a very dusty one; and the woman's lungs were found, after death, discoloured as described. There is no difficulty in such cases in detecting iron in the sputum by hydrochloric acid, and ferro-cyanide of potassium.

Quartz, Sandstone, or Clay.—Dr. Greenhow* points out that in certain districts in England workmen engaged in occupations which expose them to the dust of the siliceous or argillaceous materials are specially prone to die of phthisis; and Markel has proposed to term the disease of the lungs, resulting from the inhalation of such dust, *Chalicosis* (*χάλιξ* = gravel). Kussmaul points out that silica is present in greater or less quantity in the lungs of most persons, being derived from the dust of the streets and roads blown up by the wind.

Fatal forms of disease from the inhalation of fine dust are met with in the grinding or polishing of steel instruments, known in Sheffield as "grinders' rot;" in pearl shell-cutting; and in china-scouring, where the loose flint-powder is rubbed off from the china, after it has been baked, with sand-paper.

* Sir John Simons' third "Report to the Privy Council," 1861.

In all these conditions particles of fine dust may be detected in the sputum.

Cotton and Flax.—In the carding of cotton, and the hackling and carding of flax, minute particles of these materials have been found in the lung after death. They may be expectorated, and detected microscopically.

7. *Débris of Lung-tissue—Elastic Fibres.—Débris* of lung-tissue is met with only in destructive disease of the lung, as in bronchiectasis with ulceration of the bronchi, caseous pneumonia, pulmonary abscess, or gangrene. In cases of advanced pulmonary consumption elastic fibres are commonly met with, and their existence in the sputum may be demonstrated, as suggested by Fenwick, as follows:—Boil the specimen of sputum with an equal quantity of a solution of pure caustic soda (grs. 15 to ℥i.). This dissolves the mucus in three or four minutes. The resulting liquid is poured into a conical glass, which is filled up with pure water, and the deposit which is thrown down is carefully examined microscopically, when fibres of elastic tissue may be observed. As a rule, these fibres are not found in gangrene of the lung, being destroyed by some unknown substance, probably acting as a ferment.

8. *Parasitic growths.*—Fungi represents the thalli and spores of the *Leptothrix bucallis*, the thrush parasite (*Oidium albicans*), and occasionally *Sarcinæ* are found in sputum. The *Bacillus subtilis*, already referred to in describing the composition of fur on the tongue, may also be present; it constitutes the butyric acid ferment and exactly resembles Cohn's *Bacillus anthracosis*, from which however it differs in being mobile.

The *Leptothrix* and *Oidium albicans*, though ordinarily found in the mouth, are readily detached from the mucous membrane

and carried downwards into the lungs by the inspiratory current of air; should they meet with stagnant secretions, such as those existing in dilated bronchi and pulmonary cavities, a rapid growth takes place, hence their presence in the sputum of phthisis, bronchiectasis, and gangrene of the lungs. It is probably owing to decomposition produced by these bodies that fœtor is produced in secretion formed in caverns in the lung.

The long rod-like bodies known as *Vibriones* are frequently observed in secretion from gangrenous cavities and dilated bronchi.

Three forms of bacilli have been specially noted as occurring in the sputum—those present in diphtheria, tuberculosis of the lung, and pneumonia.

1. In diphtheria, micrococci, single, in chains, or as zooglœa, are met with, as well as the rod-shaped *Bacterium termo*. The systematic investigations of Löffler show that a peculiar bacillus is found in diphtheria, consisting of little cylinders with a peculiar club-like swelling at their ends.

2. Pulmonary tuberculosis is attended with expectoration, in which the tubercle bacillus of Koch is frequently found. The organisms are minute rods with slightly curved and rounded ends, in length being equal to from one-quarter to one-half the diameter of red blood-corpuscles, and in breadth one-fifth to one-sixth of their length. The method of their detection in sputum, according to Dr. Gibbes,* who employs a modification of that proposed by Ehrlich and Weigert, is as follows :—

A thin layer of the sputum is spread out on a cover glass and allowed to dry. The glass is then passed through the flame of a Bunsen burner, and afterwards cooled. It is next

* *Lanc t*, 1862.

placed face downwards in a watch-glass containing two or three drops of a freshly filtered solution of magenta crystals and pure anilin. (Magenta crystals, two grm., pure anilin, three grm., dissolved in twenty cc. each of alcohol, sp. gr. 830, and distilled water). After fifteen or twenty minutes the cover is removed, and washed in a dilute solution of nitric acid (one part to two of water) until all colour has disappeared. It is then washed in distilled water until a faint colour reappears. Next, it is placed face downwards upon a few drops of a saturated solution of chrysoidin until it has acquired a brown colour; it is then removed from the solution, allowed to dry perfectly in the air, and mounted.

3. The occurrence of special microphytes (pneumococci) in pneumonia was first discovered by Friedländer in 1882. The pneumococcus is more or less oval in shape, visible under a power of 600 diameters, and possesses usually a distinct capsule. The micrococci occur most frequently in pairs, the two lying in close juxtaposition, and surrounded by an envelope (Diplococcus pneumoniæ); occasionally they are met with singly or in chains. They are detected in croupous pneumonia as soon as the characteristic rusty sputum makes its appearance. Friedländer* points out that the organisms possess no single microscopic characteristic which can be said to distinguish them from other organisms, and that in determining their nature regard must be had to their cultivation, appearances, and to the result of their inoculation into animals. The existence, however, of micro-organisms, which are specially characteristic of pneumonia, may be regarded as still unproved. Dr. Klein† has pointed out, that whilst pneumococci are freely present in the sputum of pneumonia, they

* Virchow's Arch. Band 87. XXXVII.

† Fourteenth Annual Report of the Local Government Board, 1885.

are merely septicæmic organisms, and are most abundant in sputum which has been allowed to stand for a time.

GENERAL CLASSIFICATION OF SPUTA.

Sputa may be classified under the following groups, according to the prominent physical conditions which characterise each:—

1. Mucous.
2. Muco-purulent.
3. Purulent.
4. Serous.
5. Fœtid.
6. Sanguineous.

1. *Mucous Sputum*, as its name indicates, consists almost entirely of mucus. It is expectorated in health and in the early stage of bronchial catarrh.

2. *Muco-purulent Sputum.*—This variety is the one most commonly met with, occurring in the later stage of bronchial catarrh, and in almost every affection of the bronchi and parenchyma of the lungs. It consists of mucus mixed in various proportions with pus. When allowed to stand for a time the latter usually separates from the mucus and falls to the bottom of the spitting-cup, whilst the mucus, mixed with air and presenting a frothy appearance, lies upon the top. Upon turning the vessel to one side, or everting its contents, the yellow colour produced by the pus corpuscles can be observed.

3. *Purulent Sputum* presents the same appearance as pus under ordinary conditions. It is a yellowish homogeneous liquid, thick, not capable of being drawn into threads, and free from air and mucus. It is met with in empyema opening into the bronchi, in purulent infiltration of the lung after pneumonia, and in abscesses of the lung.

4. *Serous Sputum* is a thin transparent fluid, usually copious

in quantity, and resembling in appearance rice water. It is met with in œdema of the lungs. Being composed mainly of serous exudation it contains a considerable amount of albumen.

5. *Fœtid sputum* has been already referred to when discussing the existence of crystalline bodies in the expectoration. It is a muco-purulent form which is met with in putrid bronchitis, associated with bronchiectasis and in gangrene of the lungs.

6. *Sanguineous Sputum.*—Blood, as has been already pointed out, may be expectorated pure, or it may tinge in various shades the sputum with which it is incorporated. Its presence may indicate the rupture of some of the pulmonary vessels, or of some of the large arterial trunks in the thorax, but frequently it is due to *diapedesis*—that is, to the red blood-corpuscles making their way through the uninjured walls of the blood-vessels.

The most common form of sanguineous sputum met with is, probably, the rusty expectoration of pneumonia.

THE PHYSICAL PROPERTIES OF SPUTA.

The physical properties of sputum refer to its consistence, form, colour, odour, quantity, and weight.

Consistence.—The consistence of sputa varies within very wide limits, depending upon the relative amounts of water and mucus which they contain. The expectoration may consist almost entirely of water mixed with a trace of mucus, when it is got rid of with the utmost facility, or it may be composed of extremely tough tenacious masses, which are expelled only after long paroxysms of cough. In chronic forms of tracheitis and bronchial catarrh the presence of this tough tenacious sputum indicates the existence of more or less intense irritation.

Form.—Sputum may be homogeneous in appearance where

matter is expectorated from a pulmonary abscess, in empyema with bronchial fistula, &c. It occurs in rounded pellets, of great toughness and tenacity, as in catarrh of the largest air tubes; or it occurs in a less tenacious form where the masses discharged are isolated from each other, more or less rounded in contour, but flattened upon the surface, and resembling somewhat the appearance of coins—hence the name given to it of the *nummular sputum.*

Colour.—The colour ordinarily varies from white or yellowish white to yellow, according to the amount of pus cells which are present. Its colour from admixture with blood, bile, or foreign matters of different kinds, varies from an orange or rusty tint to bright or dark red, brown or black.

When blood is retained for any considerable time in the bronchi, it may undergo all the changes of colour which are observed when blood is effused into the tissue of the skin, as in an ordinary ecchymosis; hence the expectoration, under such circumstances, may change from red to yellow, yellowish-green, or even grass-green in hue. These changes represent successive stages in the higher oxidation of the colouring matter of the blood (hæmoglobin).

Odour.—Sputum may be free from smell; it may present an odour of a mawkish or mouldy character; or be like that which pervades a soap manufactory (Guttmann). In putrid bronchitis it usually resembles that observed in examining a gangrenous lung *post-mortem,* but in other cases it has quite a different character, being described by Dr. Laycock as like "that of Mayflower or of Apple-blossom with a kind of *arrière gout* of fæces." This kind of smell is often detected by holding the face close to the patient's mouth when he coughs, or whenever a large quantity of sputum is expelled with a gush from the dilated tubes.

Quantity.—The quantity of expectoration may be extremely small in acute affections, and in many chronic diseases affecting the bronchi it may be absent for a time. In other cases it is extremely profuse, and large quantities may be discharged by each cough. In bronchiectasis the largest amount of sputum is got rid of, being mostly expectorated in the morning, after sleep, during which the reflex excitability of the larynx is diminished; it is coughed up "by mouthfuls," the spittoon being filled in a very short space of time.

Weight.—The weight of the sputum is simply an indication of its consistence and the amount of air which it contains. Sputa may sink in water and retain their shape if dense, tenacious, and free from air. In a mixed form the dense constituents, formed principally of pus, sink to the bottom of the vessel containing it, whilst the lighter elements, made up of mucus and air, float upon the surface.

SPUTA IN VARIOUS DISEASES.

1. *Pneumonia.*—The sputum in the stage of red hepatisation is extremely tenacious, free of air, adheres to the bottom of the spitting cup, and is of a rust-colour from admixture with blood; it is termed "*rusty expectoration.*" It is got rid of with difficulty, and often requires to be removed from the lips by the handkerchief. Its colour may vary from a pale apple-yellow to bright scarlet when largely admixed with arterial blood.

In some cases the sputum is thin, watery, and of a brownish-red colour, so that it is compared to prune-juice: "*prune-juice expectoration.*"

Microscopically the sputum consists of red blood-corpuscles, leucocytes, long threads of mucus, large round pigmented epithelial cells and bronchial casts. The casts can be examined

after teasing out the sputum under water. They represent moulds of the minute bronchial tubes and their dichotomous divisions.

In some cases the sputum has a distinctly greenish hue when mixed with biliary colouring matter—*bilious pneumonia.*

In the stage of resolution the rust-colour fades and the sputum becomes yellowish and opaque; it is no longer tenacious, and becomes by degrees diminished in quantity, more transparent and watery, until finally it is merely a slight mucoid discharge, which ceases entirely as the patient convalesces.

Should pneumonia end in purulent infiltration, pus is freely expectorated; if in gangrene, the characteristic sputa and odour from the breath are produced.

It sometimes happens that pneumonia is unattended with expectoration (Graves), or that it is swallowed as it reaches the pharynx. The latter condition is frequently observed in the pneumonia of children.

2. *Pleurisy.*—Pleurisy, though usually free from expectoration, is sometimes attended with a discharge from the lung of a clear serous fluid like very thin mucilage or rice-water. This is termed "*rice-water expectoration.*" The sputum is associated with an œdematous condition of the lung lying subjacent to the affected pleura, the œdema being of an inflammatory kind and indicated by the existence of a *subpleural crepitant râle* (see p. 89). The characters of the sputum are those observed ordinarily in œdema of the lung, occurring in Bright's disease, &c.

Albuminous expectoration.—It occasionally happens, after tapping the chest in pleural effusion, that expectoration almost similar in physical character to the fluid withdrawn by aspiration, is coughed up in large quantity. In two cases of this

condition observed by the writer, more than a quart of serous-looking frothy fluid was coughed up in the course of a day. It was supposed that in such cases a communication had been established between the lung and the cavity of the pleura, and that the fluid expectorated was that left in the pleural sac after *paracentesis*. This view is, however, incorrect, as the sputum represents a condition of acute hyperæmia of the lung, attended with a rapidly-formed fluxionary discharge, occurring from vessels over-distended after the removal of pressure on the lung, and having walls which are, probably, preternaturally pervious. The sputum was specially described by French observers under the name of "*expectoration albumineuse.*"

3. *Tuberculosis of the Lungs—Phthisis.*—The sputum in phthisis varies much according to the nature of the disease, the intensity of inflammation present, and the stage of the affection.

In tubercular phthisis, both of the acute and chronic forms, in the first stage, the expectoration consists merely of a catarrhal discharge from the bronchial mucous membrane. Later on it contains tubercle bacilli and pus, is frequently streaked with blood, and becomes profuse and clotty. When cavities are formed the sputa are firm, assume a rounded or nummular character, are of a yellowish green or dirty grey colour, and free of air—hence they sink in water. Microscopically, besides tubercle bacilli, the sputa contain pus cells, free nuclei, and elastic fibres. When the sputum is mixed with blood it presents a different coloration according to the amount of blood present, and as the blood is effused, recently or of old date. It will vary in colour from a light red to reddish brown. Bloody sputum is usually mixed with a quantity of bronchial and buccal secretion, which, being very thin and mixed with air

bubbles, floats on the surface of the fluid in the expectoration cup.

All the varieties of sputum described are met with in phthisis depending upon pneumonia, attended with diffuse caseous degeneration. Speaking generally, the character and amount of expectoration in phthisis depends upon four conditions :—1. The extent of implication and degree of irritation of the bronchial mucous membrane. 2. The size of cavities, and the rapidity of their formation. 3. The situation of such cavities in the lungs. 4. The nature and site of their communication with the bronchi.

With regard to the relation of tubercle bacillus to phthisis, what has been noted by various observers may be summarised as follows :—

According to Klein, there is no bacillus without tubercle, and no tubercle without bacillus.

The presence of tubercle bacilli in sputum is not *necessarily* attended with pyrexia, and in such cases no loss of bodily weight takes place.

Diagnosis by the presence of bacillus is so precious that it precedes all other methods of investigation by months, and often years (Germain Sée).

In early phthisis there is no direct relation between the numbers of the bacilli and the gravity of the disease. In some cases, although numerous at first, they may completely disappear with apparent recovery.

In the later stages of phthisis the bacilli cannot be said to have any definite relation to the progress of the disease, as they may be absent or few in number in the expectoration. When, however, they exist in excessive numbers a speedily fatal issue is portended.

4. *Putrid Bronchitis and Gangrene of the Lung.*—In

both diseases the sputa present characters which are common, as they are associated with a putrefactive destruction of pulmonary tissue produced by the entrance of bacteria or spores into the air passages. Traube's description of the expectoration may be accepted as full and correct:—" The sputa are very abundant, of a somewhat fluid consistence, and of dirty greenish colour. They separate into three strata on standing; the uppermost layer is greenish yellow, opaque, and frothy; the middle layer is strikingly transparent, albuminous, and serous in consistence; the undermost layer is opaque and yellow, consisting mainly of swollen pus corpuscles, and a detritus in which is found a number of 'cores,' or 'plugs,' varying in size from a millet seed to an oat grain, having an exceeding offensive odour, and containing the needle-shaped crystals of fatty acids already referred to" (p. 108 and Fig. 20).

Fig. 20.

Crystals of fat acids.

These cores are known as Traube's or Dittrich's plugs.

5. *Sputum in Bronchiectasis.*—In bronchiectasis, from prolonged irritation, the dilated tubes have lost, to a great extent, their sensibility; hence secretion from their walls may be retained until it reaches a large quantity. It is then coughed up; sometimes in such an amount as to fill a large spitting-cup in

a few moments. The discharge is most marked after waking in the morning, it having accumulated during sleep. The secretion resembles in character that of chronic bronchial catarrh, being of a yellowish-green or dirty greenish-white colour, more or less homogeneous and confluent. After a time it usually separates into layers—the upper being transparent and fluid; the lower opaque, and consisting exclusively of pus; the middle consisting of flocculent mucus.

The sputum in bronchiectasis may continue like that of chronic bronchial catarrh, but it very frequently acquires a fœtid odour, like that pervading a soap manufactory (Guttmann). This is due to its stagnation in the cylindrical or sacculated bronchial tubes, the offensive smell being most marked when the matter is expectorated; when it rests for a time exposed to the air the fœtor subsides.

When, in bronchiectasis, ulceration of the bronchi takes place, and, owing to the presence of septic organisms, putrefactive decomposition of the retained secretion sets in, the sputum acquires the characters described as existing in putrid bronchitis and gangrene of the lung.

CHAPTER VI.

EXAMINATION OF THE ORGANS OF CIRCULATION—HEART AND GREAT VESSELS.

THE methods adopted in the examination of the heart are similar to those used in the examination of the lungs, viz. :—

1. Inspection.
2. Palpation.
3. Percussion.
4. Auscultation.

It is necessary, however, before entering upon the consideration of these methods, that a general outline should be given of the relation which the heart has to particular points on the chest wall.

The position of those parts, delineated by Quain and Gibson, may be given as follows :—

Nearly two-thirds of the heart lie to the left of the middle line of the sternum.

Right Auricle.—It lies behind the sternal ends of the third, fourth, and fifth right costal cartilages, the intervening portions of the intercostal spaces, and the right edge of the sternum. The tip of the auricular appendix corresponds to the centre of a line connecting the upper borders of the third costal cartilages.

Left Auricle.—It extends vertically from the level of the lower border of the second left costal cartilage to the upper border of the sternal end of the fourth; and in breadth it corresponds to the body of the eighth dorsal vertebra and the head of the adjoining rib. The tip of its appendix lies in the lower part of the second intercostal space, about one inch and a quarter from the left margin of the sternum.

Fig. 21.

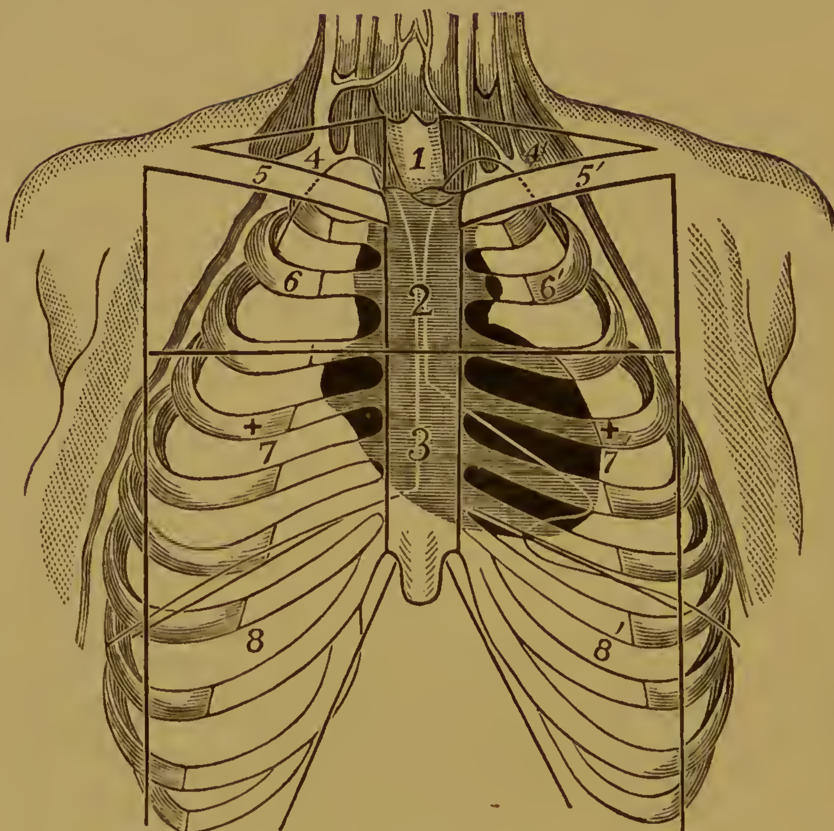


Diagram showing the position of the heart in relation to the regions of the chest.

Right Ventricle.—It extends from the third to the sixth cartilages on the left side; the conus arteriosus, its most prominent part, is uncovered by lung.

The Auriculo-ventricular Furrow, or sulcus, corresponds with a line obliquely drawn from near the sternal end of the sixth right costal cartilage to the upper border of the junction of the third left cartilage with the sternum. The *rounded margin* (*margo obtusus*) formed by the left ventricle extends from the third left cartilage to the fifth intercostal space, corresponding to a point about two inches to the left of the nipple line. The *sharp margin* (*margo acutus*) formed by the right ventricle passes from the sternal end of the sixth right cartilage, nearly transversely behind the seventh right, ensiform, and seventh left cartilages, meeting the other margin at the apex.

The Apex of the Heart is situated in the fifth intercostal space, close to the upper margin of the sixth rib, three and a half inches from the middle line of the sternum. The orifices of the heart lie in close proximity to each other. Both *auriculo-ventricular openings* lie slightly to the left of the line which indicates the position of the auriculo-ventricular sulcus.

The Right Auriculo-ventricular Orifice lies behind the sternum on a level with the fourth intercostal space.

The Left Auriculo-ventricular Orifice lies behind the left half of the sternum on a level with the fourth costal cartilage.

The *Pulmonary Orifice* is situated immediately to the left of the sternum, behind the edge of that bone and the third cartilage; the trunk of the pulmonary extends up to the second left costal cartilage.

The *Aortic Orifice* also lies partly behind the left half of the sternum, on a slightly lower level than the pulmonary opening, being covered by it in one-fourth of its diameter. The aortic opening is opposite the *lower* margin of the third left cartilage.

and third intercostal space, and is immediately behind the posterior wall of the conus arteriosus.

INSPECTION.

In health, and during rest, the only movement of the heart detected by inspection is an elevation of the chest wall in the fifth left intercostal space, about one inch and a half below and three-quarters of an inch to the right of the left nipple. Its localisation may also be defined as existing in the fifth interspace, midway between the mammary line and the edge of the sternum.

The impulse does not, as a rule, vary as regards its vertical position whilst standing erect, but it may be displaced as far as the mammillary line when lying on the left side, when it becomes more distinct as the heart lies nearer to the chest wall; when lying on the right side the beat becomes somewhat indistinct. In children the impulse is often raised as high as the fourth interspace, from the diaphragm being drawn upwards with great force by the highly elastic lungs, and it is also found as far outwards as the nipple line. By a deep inspiration it is depressed by at least half an inch, sometimes sinking behind the sixth rib. In the aged, it is often found in the sixth intercostal space, the displacement downwards being due to diminution in the elasticity of the lungs and of the large vessels springing from the heart.

The impulse beat is frequently not visible, being obscured when the chest wall is rigid and covered with an increased amount of fat; when the muscles are powerfully developed; or when the lung is abnormally spread over the heart. When the action of the heart is greatly excited, an undulatory movement of the tissues over the entire cardiac region may be observed, and also a pulsation in the epigastrium from the throbbing of the right ventricle.

The vibration which can often be felt between the third and sixth costal cartilages and at the lower end of the sternum is called the *valvular impulse.*

Causation of Impulse Beat.—During the impulse beat the heart undergoes a marked change in shape as well as a change in position, and these two conditions cause the cardiac impulse. The change of shape involves a considerable increase in thickness and firmness of the ventricles as well as their shortening; whilst the altered position involves a displacement of the apex of the heart downwards, forwards, and to the right side.

Although ordinarily spoken of as the apex beat, it should be borne in mind that the impulse is really best felt corresponding to a spot upon the anterior surface of the right ventricle, about three-quarters of an inch above the apex of the heart; the apex is separated from the chest wall by a layer of lung of considerable breadth. The changes in the shape and position of the heart during the impulse may be given as follows:—

1. The base of the heart during diastole is of the shape of an ellipse; during systole it becomes circular. The base being hardened and brought nearer the chest wall during the ventricular contraction, the apical portion is free to execute its lateral and rotatory movements.

2. During diastole, the ventricle lies with the apex directed obliquely downwards, so that its long axis lies in an oblique position, and forms with the diameter of the base angles which are unequal. During systole the apex is erected, from below and behind, forwards and upwards (*cor sese erigere*, Harvey); the ventricular axis becomes perpendicular to the diameter of the base, and the hardened apex is thrust into the intercostal space (Ludwig).

3. The ventricle is spirally twisted or rotated on its long

axis during systole, so that the apex is brought from behind forwards, and a great portion of the left ventricle is turned to the front. This movement of rotation is effected by the spiral fibres of Reid, which arise at the base from the fibrous rings between the auricles and the ventricles, and then, passing downwards, twist spirally around the apex. It is also assisted by the slightly spiral arrangement of the aorta and pulmonary artery (Kornitzer).

4. During diastole the intra-cardiac pressure is equal upon all parts of the inner surface of the ventricle; but during systole, when the outlets are opened, the pressure corresponding to these must be less than the parts diametrically opposite, so that a recoil movement downwards and somewhat forwards of the apex takes place. This recoil, or "reaction impulse," is similar to force which sets in motion a Segner's water wheel, or which produces the recoil that follows the discharge of a gun, &c. This view as to the cause of the impulse beat is known as the Gutbrod-Skoda theory. It is of interest in accounting for diminution or loss of impulse beat in cases of constriction of the aortic orifice.

5. During systole the elongation of the aorta and pulmonary artery tend to press the apex downwards and forwards into the intercostal space.

In disease, by inspection, abnormalities of the wall of the chest in relation to the heart and great vessels are observed, as well as alterations in the character and position of the impulse beat. In rare cases of extreme increase in the size of the heart, and in extensive effusion into the pericardium, especially occurring in children, a protrusion of the left breast may be observed (*la voussure* of French authorities). In aneurysm involving the heart or aorta, a protrusion of the chest-wall corresponding to the site of the tumour is sometimes observed.

The impulse beat is frequently altered in character as well as in position. It may be increased in force or diminished, diffused over a large extent of surface, and displaced to the right or left, downwards or upwards.

It is *increased* and diffused in character, in conditions which excite and strengthen the cardiac contractions, as in febrile states, in some inflammatory conditions of the heart, in cardiac palpitation, and in increase of the muscular structure (hypertrophy) of the heart. It is also increased, and of a fluctuating or undulating character, in cases where there is retraction of the overlapping pulmonary margins especially affecting the left lung.

It is *diminished* in cases where the action of the heart is greatly weakened, as after a prolonged illness, or in the terminal stage of acute diseases; in fatty degeneration of the muscular structure; where the heart is separated from the chest-wall by any medium, such as the intervention of emphysematous lungs, the presence of fluid or gas in the cavity of the pericardium, or an excessive deposition of fat in the parietes; and in cases of pericardial adhesion. The diminution or absence of impulse beat in aortic stenosis, and extreme mitral stenosis, will be discussed in another section.

The position of the apex beat may be displaced from conditions outside the heart itself (extrinsic), or from alteration in the size and shape of the heart (intrinsic).

1. The *extrinsic* conditions causing displacement are alterations in the position of the diaphragm, and diseases involving accumulation or wasting within the chest.

If the diaphragm is depressed, the heart sinks as a whole—hence the displacement downwards of the apex beat in emphysema, in pleural effusion, or pneumothorax. In large effusions of fluid or air in one pleura, the displacement is lateral, and the apex beat, in place of being depressed as it is

in moderate effusion, may be slightly elevated. Thus, in left pleural effusion, the heart's beat may be felt in the right axillary line and in the fourth interspace. In its displacement from left to right the heart has to pass over the central portion of the diaphragm, against which it rests more or less obliquely in the normal position, but, in its altered position, the axis of the heart becomes more and more vertical, until, finally, the apex becomes the part which is situated furthest to the right, so that, although the diaphragm is depressed, this condition, as far as the heart is concerned, is compensated for by the apex having to cross over the highest part of the muscle.

In right pleural effusion the heart is pushed to the left and may be found beating in the left axillary line. It is not so commonly displaced in right as in left pleural effusion, in consequence of the position which the heart occupies in the chest.

If the diaphragm be elevated the apex beat will be displaced upwards. This occurs in wasting diseases of the lungs (fibroid phthisis), or from the non-expansion of a lung after the absorption of a pleuritic exudation. The diaphragm may also be elevated from various affections within the abdomen—ascites, tympanites, tumours, enlargements of the various abdominal organs, &c. In such conditions the apex beat is displaced upwards.

Amongst the diseases of accumulation which may be mentioned as causing displacements of the apex beat are—aneurysm of the aorta and tumours of the mediastinum. Pericardial effusion, if considerable in amount, elevates and displaces outwards the apex beat, so that it may be felt in the fourth intercostal space over the nipple line. It very frequently so obscures the impulse as to render it inappreciable by inspection or palpation.

2. The *intrinsic* causes of displacement of the apex beat are

those which involve an increase in size of the heart—hypertrophy and dilatation.

In hypertrophy and dilatation of the left ventricle the apex beat is displaced downwards to the sixth, seventh, or even eighth interspace, and outwards, towards, or to the left of, the mammillary line. The displacement is due to the great increase in the long axis of the heart.

Fig. 22.

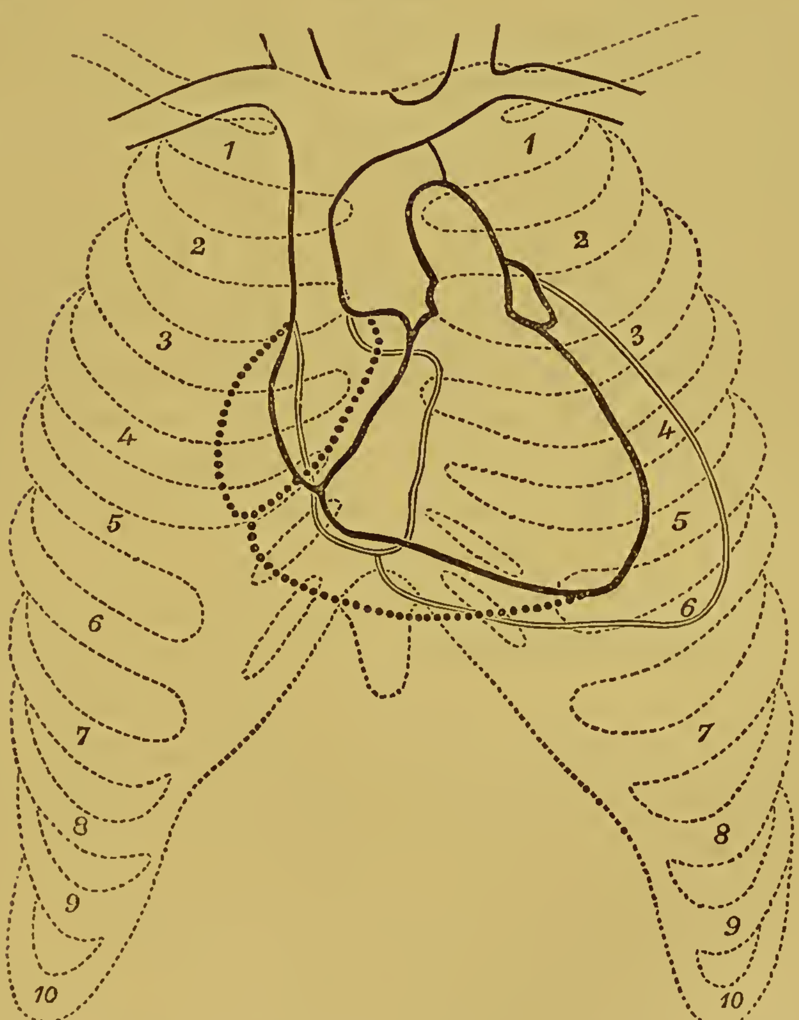


Diagram showing hypertrophy and dilatation of the left side and the right side of the Heart, respectively. Von Dusch.

In hypertrophy and dilatation of the right ventricle an impulse beat frequently is to be seen in the epigastrium at the right margin of the sternum, whilst the normal apex beat may be displaced to the left and diminished in intensity.

Instead of a protrusion or elevation of the chest-wall as a result of the cardiac contraction, a *retraction* can sometimes be observed corresponding to the normal site of the apex beat, and sometimes extending over nearly the præcordia, so that the sternal ends of the ribs and lower end of the sternum are drawn inwards. This condition is spoken of as *retraction impulse.* Although supposed to indicate an adherent pericardium, it is conceded that unless a *diastolic recoil* of the parts which are retracted takes place, *retraction impulse per se* is not a reliable sign of disease. When systolic retraction exists with diastolic recoil, Friedreich points out that an adhesion exists between the inferior surface of the heart and the diaphragm; this adhesion causes, during systole, the diaphragm to be strongly drawn upwards, so that a strong traction is exercised upon the parts of the thorax which correspond to the insertion of the muscle, and they are, consequently, drawn inwards.

Systolic recessions of the chest-wall are observed in persons who are very thin, but in a normal condition of health; they are perceptible in the third and fourth intercostal spaces, and are seen best when the heart is acting energetically. They may exist, in an exaggerated degree, in hypertrophy of the heart. It is said that these recessions are due to the systolic displacement of the apex *downwards and forwards,* being combined with a movement of the base *backwards and to the right,* so that an empty space is created between the base of the heart and the chest-wall, to fill up which the soft parts are dragged inwards. The explanation is, however, not satisfactory, as recession movements are but rarely observed, whilst

they should be constant if the explanation offered for their presence held good.

Besides the apex beat and recession of the chest-wall, impulses may be seen in disease over different regions of the thorax. These impulses are met with corresponding to the situation of—1, the conus arteriosus; 2, the pulmonary artery; 3, the right auricle.

1. Impulse of the conus arteriosus is observed in cases where the heart is displaced to the right side. In such cases the impulse, instead of being caused by the striking of the apex of the ventricle against the chest wall, is the result of the impact of the conus arteriosus against it.

2. Impulse in the situation of the pulmonary artery (second left interspace), systolic in tone, can be observed in wasting diseases of the upper lobe of the left lung.

3. Impulse of the right auricle, systolic in time, has been observed in the fifth right interspace and parasternal line, where the right auricle is thinned and dilated. It is due probably to a sudden filling of the auricle during the ventricular systole, when the auriculo-ventricular valves are closed.

EPIGASTRIC IMPULSE.

A systolic impulse is frequently observed in the epigastrium under a variety of conditions. It may exist in health after violent exercise from forcible contractions of the heart which are transmitted to this region. Its occurrence in disease will be dealt with in the section on palpation.

PULSATION IN THE GREAT VESSELS.

Inspection of the large arteries affords important evidences of diseased conditions, either confined to the vessels themselves, or due to lesions of the heart and its valves.

INSPECTION OF THE ARTERIES.

In the aged, where there is marked senile degeneration of the arteries, the large vessels pulsate prominently, and, during the formation of the pulse, they often appear *dilated* and *tortuous*. In such persons, if the forearm be flexed, the brachial artery may be observed, not alone to be thrown into a number of curves during the passage of the pulse-wave, but to be displaced a considerable distance from its bed during each systole of the vessel. This form of pulse is known as the *locomotive pulse.* It is observed also in patency of the aortic valves—a lesion which is attended with visible pulsation in all the large arteries, especially those of the neck—*the pulse of unfilled arteries—water-hammer pulse.*

INSPECTION OF THE VEINS.

Inspection of the large veins is chiefly concerned with conditions of the circulation in the veins of the neck. These conditions may be classed under the heads of *Engorgement* and *Pulsation.*

ENGORGEMENT OF THE VEINS.

Engorgement of the cervical veins—especially the external jugular—may be present independently of disease, owing to their vertical course, and from the influence which the respiratory acts exercise upon the circulation through them. In inspiration the flow of blood is accelerated, in expiration it is retarded—and during this act, when forcible in character, the superficial cervical vein may be observed standing out as distended bluish cords.

Pathologically, congestion of all the veins of the body, particularly those of the neck, is observed in extreme distension and weakened power of the right ventricle; or when, from pressure upon the vena cava, these veins are unable to receive all the blood flowing towards them. This latter

condition arises whenever there is a persistent increase in intrathoracic pressure, as in large effusions into the pericardium, or pleura, pneumothorax, aneurysms, or mediastinal tumours, and in the extreme forms of pulmonary emphysema. The engorgement of the cervical veins is most conspicuous when the patient lies in the prone position, as in the vertical position the flow of blood towards the right auricle is accelerated. In expiration, and especially during cough, the veins become most markedly turgid, the sinus above the clavicle forming a large and prominent swelling.

In most cases of persistent *engorgement* of the veins, a faint movement of *undulation* is observed in the jugular veins. The movement represents a succession of waves passing along the vessels, which may or may not possess a rhythmical character. The *undulating* movements are due mainly to the influence exercised upon the venous circulation by the expansion and contraction of the chest during respiration, and to some extent by the cardiac pulsations, mainly the sharp, swift, auricular contractions.

PULSATION OF THE VEINS.

When the over-distended internal jugular veins have their walls rhythmically elevated during the cardiac systole, the condition is described as *venous pulsation*. The pulsation may extend through the entire of the jugular vein, or be confined to the sinus; it is perceptible by inspection and palpation. Some care must be exercised in distinguishing the pulsation in the vein itself from one communicated to it from the neighbouring carotid, and the position of the head should be so altered as to separate the vessels as far from each other as possible. *Pulsation* can be distinguished from *undulation* by compressing the vein with the finger, the part below the seat of compression—that is, nearest to the heart—continues to

pulsate, and in an intensified degree, if the movement be pulsatile, whilst *undulation* completely disappears from it. If the pulse in the vein were communicated from the carotid, it would be visible above the seat of compression where the vein was full, whilst it would cease to appear below the point compressed.

The venous pulse usually consists of a single throb, and is developed only when the valves at the origin of the vein are incompetent. In the normal condition the closure of the valves and the circular fibres of the right auricle prevent us seeing the retreating waves which follow the auricular contraction. When the jugular valves are incompetent, then, during the auricular systole, a wave of blood is sent backwards into the distended jugulars, and so a pulsation, presystolic in time, is produced. If, in addition, the tricuspid valves be incompetent, the throb, in place of being single, is double, the second and stronger beat being caused by a large retreating wave of blood, which is sent backwards at the auricle through the incompetent auriculo-ventricular orifice at the time of the ventricular contraction. Double pulsation in the jugular vein may then be regarded as a pathognomonic sign of tricuspid incompetency, either absolute or relative. By absolute tricuspid incompetency is meant a condition of organic disease of the valve which renders it unable to close its opening; relative incompetency refers to such an excessive distension of right chamber of the heart, from the undue amount of blood which reaches it, that the tricuspid valve is insufficient in extent to close the over-distended orifice. This latter condition is the one which is most frequently met with, usually associated with mitral stenosis (contraction) or regurgitation, and in the advanced stage of pulmonary emphysema, where there is obliteration, in a marked degree, of the capillary circulation in the lungs.

Whenever the venous pulse is fully developed, it can be

felt as well as seen; when but faintly developed it is perceptible only by inspection. In tricuspid insufficiency the first pulse (presystolic) is feeble and followed by the stronger and more defined beat (systolic). Where the double beat exists the pulse is said to be *anadicrotous*—that is, the double beat occurs in the rise of the pulse.

A sudden diastolic collapse of the cervical veins has been described by Friedreich as a sign of adherent pericardium. During systole the diaphragm is raised, and the parts of the chest into which it is inserted are drawn inwards—viz., the ribs and sternum. The venous flow is at this period retarded, and the cervical veins present the appearance of engorgement. In diastole, when the retracted parts regain their position, the flow of venous blood is accelerated—hence a rapid collapse of the turgid veins.

Occasionally in tricuspid incompetency a pulsation is developed in the inferior cava, which communicates an impulse to the hepatic veins, and so causes a rhythmical pulsation of the liver corresponding to the beats of the heart. In part, no doubt, the pulsation is due to a communicated impulse conveyed to the liver by the throbbing of the inferior cava (hepatic pulsation).

In rare instances a pulse is observed in the veins on the back of the hand and dorsum of the foot, owing to the arterial pulse being propagated through the capillaries into the veins. It is met with specially in cases where the pressure in the arteries is pathologically increased or diminished, as in aortic patency. In this disease a "capillary pulse" may be observed by pressure on the finger-nail, when the skin will be seen to grow red and pale with each pulsation of the heart. Some observers (Quincke, Peter, and Broadbent) have shown that a venous pulse may be developed, under normal circumstances, when the peripheral ends of the arteries become dilated and relaxed.

CHAPTER VII.

PALPATION OF THE PRÆCORDIAL REGION.

In the physical examination of the heart, inspection and palpation go together. Palpation controls or supplements the impressions communicated by inspection; many points which escape observation by inspection become appreciable by palpation.

The special phenomena which are the objects of examination by palpation may be tabulated as follows :—

1. The apex beat : its force, extent, and character.
2. Pulsations occurring over different regions of the thorax.
3. Thrills.
4. The arterial pulse.

1. *The Apex Beat: its Force, Extent, and Character.*

The situation and cause of the apex beat have been already described, as well as those conditions which produce a displacement of it. Its force, extent, and character in disease, need a few words of comment.

The force and extent of the cardiac impulse is *increased* in hypertrophy, if the condition be not neutralised by muscular degeneration or an extreme amount of dilatation. The increased impulse is of a distinctly heaving character, and is usually best appreciated by the observer putting his ear directly against the cardiac region, or listening over it with the stethoscope. In well-marked cases of hypertrophy the head of the patient is seen to be distinctly raised during each cardiac pulsation, and the force of the impulse may be estimated by the degree of pressure it is able to overcome. When the left ventricle is hypertrophied the impulse can be felt dis-

placed downwards and outwards in the sixth, seventh, or even eighth intercostal space; when the right ventricle is hypertrophied the impulse is in the situation of the epigastrium.

The force of the impulse is influenced by the thickness of the soft structures covering the chest, the position of the body, and the relative position of the lungs. In fat persons there may be, even in health, an absence of impulse; even in considerable hypertrophy of the heart, if the lungs be markedly emphysematous and completely overlap it, impulse may likewise be absent. The prone position is the least favourable for the detection of impulse by palpation—the most favourable position being that in which the patient leans forwards and towards the left side.

The extent of the impulse varies considerably in disease. It may be diffused over almost the whole cardiac region in cases of general hypertrophy of the heart, when it is associated with a great increase in the force of the impulse beat. It may be increased in extent, diffused and undefined in character, in cases of considerable dilatation of the heart, with but a limited amount of hypertrophy.

The apex beat is *diminished* in force in all conditions which weaken the heart or separate it from contact with the chest wall.

In reference to the character of the apex beat there is only one point to specially notice—namely, the occurrence of a diastolic impulse. This impulse or beat is found to follow quickly the systolic beat, and is felt in the same situation, being a sort of back stroke. It is caused by the sudden and forcible dilatation of the ventricles in cases of extreme hypertrophy.

2. *Pulsation occurring over different regions of the Thorax.*

Pulsations occurring over different regions of the thorax, apart from the cardiac area, are caused by expansions or aneu-

rysmal dilatation of the great vessels lying within the chest—viz., the aorta, arteria innominata, left carotid, and subclavian arteries.

The sudden and forcible closure of the pulmonary semilunar valves sometimes causes a diastolic impulse, which can then be felt in the second left interspace, close to the sternum. This impulse is a sign which is usually met with in cases of greatly increased tension in the pulmonary artery, arising from mitral stenosis, or regurgitation, where the right ventricle has become hypertrophied. It may also be observed in wasting disease of the upper part of the left lung, which allows the artery to come in closer relation to the chest-wall than under normal conditions. In this case the impulse is usually displaced to the left, some distance from the normal position of the pulmonary artery. It is said also to be produced by a layer of solid lung lying over the artery, and transmitting its pulsation to the surface; this is, however, a matter of some doubt.

In rare instances a diastolic impulse is felt in the second right intercostal space, close to the sternum. It is due to the forcible closure of unaltered aortic valves in marked hypertrophy of the left ventricle. This impulse is most frequently met with in arterio-capillary fibrosis, arising either independently, or in connection with contracting Bright's disease (chronic interstitial nephritis).

EPIGASTRIC PULSATION.

A systolic pulsation, which may either exist alone or occur synchronously with the apex beat, is observed very frequently in the epigastrium, and is termed *epigastric pulsation.*

After very vigorous muscular exertion, a throb is communicated to the epigastrium from the forcibly contracting

ventricles; but this pulsatile condition rapidly subsides as the heart-beats lessen in force and frequency.

Epigastric pulsation may also be produced by pulsation in an abnormal degree of the abdominal aorta and cœliac axis, arising from excessive innervation of these vessels, or from aneurysm of either vessel. Where the pulsation is due merely to abnormal innervation, the impulse is found to extend uniformly along the entire length of the abdominal aorta as far as the common iliac arteries, and is of a non-expansile character. It is usually met with in persons having thin and lax abdominal walls, as in spare women who have had repeated pregnancies—in such cases the pulsation can be readily detected by palpation.

The most common cause, however, of *epigastric pulsation* is hypertrophy of the right ventricle accompanying emphysema of the lungs. In this condition the diaphragm is depressed, so that the right ventricle is not alone displaced downwards, but comes to lie in a more horizontal position than normal; the heart undergoes a change in shape, becoming more or less square, owing to the increased size of the right side, so that the contraction of the hypertrophied and dilated ventricle in an altered position is communicated to the epigastrium. In such cases the sounds of the heart are best heard over the xiphoid cartilage or in the epigastrium, whilst the sounds heard over the seat of normal apex pulsation may be obscure or almost inaudible.

A pulsation extending to the epigastrium, caused by regurgitation of blood into the hepatic veins, has been already referred to, under the name of *hepatic pulsation*.

Recession of the epigastrium has likewise been dealt with in describing the alteration in the character of the impulse-beat which attends adhesion of the pericardium.

3. *Thrills.*—When an eddying movement is produced in the blood-stream, usually in its passage through the cardiac orifices, there is frequently conveyed to the hand, applied over the heart, a sensation of a whirring or vibratile character. Its resemblance to the purring of a cat led Laennec to term the phenomenon *frémissement cataire.* This vibration is always heard as a *murmur*, as well as felt; hence the term *palpable murmur;* but generally murmurs are audible without being attended with abnormal tactile sensations. Both murmur and thrill are caused by the vibration of a *fluid vein* (the nature of which will be discussed further on), which, however, is often too weak and fast to be appreciated by palpation.

Three varieties of thrill may be described—Systolic, Diastolic, and Pericardial.

Systolic Thrill.—A systolic thrill may be developed at any of the four orifices of the heart—the mitral, aortic, tricuspid, or pulmonary. It is usually marked over the orifice at which it is developed, though frequently intensified and carried to some distance from this, in the direction of the blood-current. Probably the most common in occurrence is the thrill which accompanies mitral regurgitation. It is felt over the mitral area (region of apex pulsation). Thrill in the second right intercostal space, close to the sternum (the aortic area) and radiating downwards towards the ensiform cartilage, arises from constriction of the aortic orifice, atheromatous degeneration of the aorta, and in aneurysm of the ascending part of the arch. Theoretically, a thrill at the lower part of the sternum might be supposed to indicate tricuspid regurgitation, but such a condition, rare in itself, is rarely attended with thrill, whilst as a matter of practical observation thrill is frequently conveyed downwards along the sternum, which acts as a sounding board in aortic valve disease.

A systolic thrill over the pulmonary area (second left intercostal space, close to sternum) is by no means as uncommon as it is generally supposed to be. Its occurrence from organic disease of the pulmonary orifice or valves is no doubt extremely infrequent. But a systolic murmur is very often met with in the pulmonary artery, under a variety of circumstances which do not involve organic disease of the vessels, and this murmur is not infrequently accompanied by thrill. This particular sound will be referred to when describing what is known as Quincke's murmur.

A systolic thrill is very frequently observed in the large arteries of the neck, especially the subclavians, in cases of aortic regurgitation. By pressing the fingers upon the subclavian artery, as it lies in the supra-clavicular region, a very distinct *frémissement* can be felt. Occasionally the sign can be elicited only by bending the head towards the artery compressed.

Diastolic Thrill.—Diastolic thrill is generally met with over the mitral area, occasionally over the aortic. It is scarcely ever met with over the pulmonary or the tricuspid orifice.

A diastolic aortic thrill is usually of a continuous character, occupying almost the entire period of diastole, and felt over the greater part of the sternum. It is observed in cases of aortic regurgitation from incompetent valves, and in the same condition associated with aneurysm of the ascending part of the arch. By far the most common cause of diastolic thrill is mitral stenosis (narrowing or obstruction). It is felt over the mitral area, and somewhat to the left of it, and occupies frequently the entire of the pause (period of diastole). Invariably the thrill becomes more marked, immediately preceding the impulse beat, up to which it leads. In most cases the thrill is perceptible only just before the apex beat, when

it is called *presystolic thrill*. When presystolic in time it might also be called, having regard to the mechanism of its production, *auricular systolic thrill*, to correspond to the nomenclature adopted by Dr. Gairdner, in reference to the murmur of mitral stenosis. This thrill, when absent, can often be developed by increasing the heart's action, as by getting the patient to walk rapidly, or if in bed to raise the arms repeatedly with a quick movement, and then to lean forwards and to the left side.

Pericardial Thrill.—In the dry stage of pericarditis a sensation of friction, like that observed in pleurisy, is sometimes conveyed to the hand. It is due to the rubbing together of the two layers of the pericardium, roughened by inflammatory exudation. Occasionally, in chronic pericarditis with a very copious exudation, fluctuation may be felt over the cardiac region.

4. *The Arterial Pulse.*—The conditions referrible to the pulse have been already discussed (p. 15, *et seq.*, Introduction).

In the examination of the pulsations of the heart an instrument invented by Chauveau and Marey is used. It is called the *Cardiograph*. The description of this instrument and the method of using it belong more to the domain of physiology than to that of practical medicine, therefore the student is referred for information on the cardiograph and its tracings to the text-books on Physiology.

CHAPTER VIII.

PERCUSSION OF THE HEART.

Percussion in the examination of the heart is employed only in the *mediate* form. Its object is twofold—firstly, to determine the extent of the heart's surface which is in immediate contact with the chest-wall; and, secondly, to define the position and extent of those parts of the organ which are overlapped by the lungs. The first object is attained by *superficial* percussion—that is, by a light stroke upon the finger used as a pleximeter. The area so mapped out is termed *that of the superficial or absolute cardiac dulness.*

The delimitation of those parts of the heart which are overlapped by the lungs is effected only by *deep* percussion—that is, by a firm forcible stroke upon the finger. The area so mapped out is termed that of the *deep or relative cardiac dulness.*

SUPERFICIAL OR ABSOLUTE CARDIAC DULNESS.

This area is irregularly triangular in shape. The right side of the triangle corresponds to the inner border of the sternum from the upper border of the fourth left costal cartilage directly downwards; the left corresponds to a slightly curved line (convexity upwards) drawn from the upper margin of the junction of the left fourth costal cartilage with the sternum, downwards to the point where the apex beat is felt—about an inch to the right of the mammillary line; the base may be represented diagrammatically by a line connecting the apex beat with the left sixth costo-chrondral articulation. The base of the triangle, which corresponds

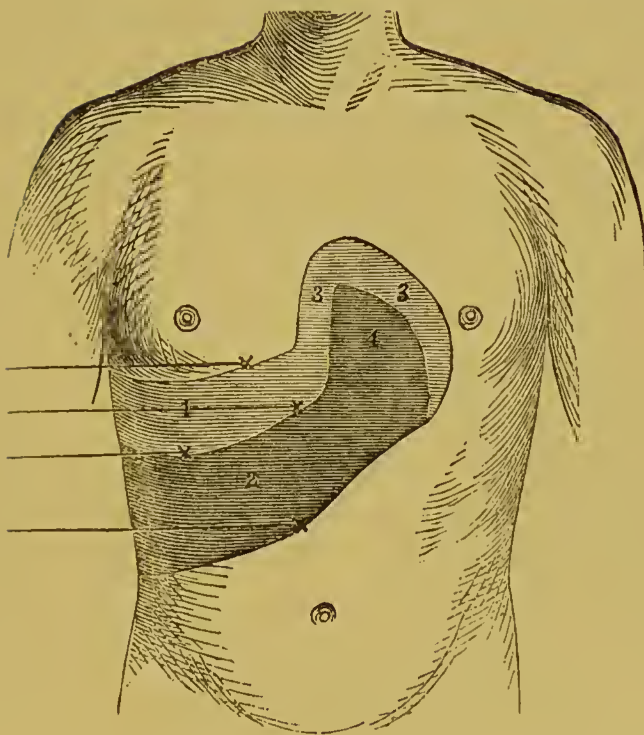
with the lower border of the right ventricle, cannot be distinguished by percussion from the dull sound which the adjacent left lobe of the liver yields upon percussion.

The superficial area thus mapped out does not correspond accurately to the extent of the heart which is in contact with the chest-wall, a portion of the right ventricle lying, not overlapped by pulmonary tissue, considerably to the right of the left margin of the sternum. The sternum, however, is readily thrown into vibration by the percussion stroke, and it serves to convey the stroke to the adjoining part of the right lung, so that the cardiac is replaced by the pulmonary percussion sound.

It should be borne in mind that the limits assigned for the area of superficial dulness hold good only when respiration is carried on almost imperceptibly, the extent of heart which is overlapped by the lungs being much diminished by a deep inspiration. In examination of the heart in disease, it may be necessary to get the patient to suspend respiration altogether for some seconds, whilst the examination by percussion is being conducted. Deep inspiration lessens the area in height and breadth, the upper limit sinking to the lower border of the fourth costal cartilage, and the left boundary line moving inwards, whilst the right remains stationary. When the patient lies upon his left side, the dulness is considerably increased to the left; whilst he lies upon his right, the area is not materially altered.

As a matter of routine, the first step which should be taken in employing percussion is the determination, in the standing or prone position, of the exact position of the apex beat. This will permit us to make due allowance for alteration in extent of percussion by change of position.

Fig. 23.



Cardiac and hepatic dulness.

1. Relative hepatic dulness.
2. Absolute hepatic dulness.
3. Relative cardiac dulness.
4. Absolute cardiac dulness.

Taken from Dr. Graham Brown (*Medical Diagnosis*).

DEEP OR RELATIVE CARDIAC DULNESS.

The deep-seated area is one which can, even in the most experienced hands, be ascertained with only an approximate degree of accuracy. It is found to reach upwards as high as the third rib, where the muffled sound is replaced by the clear note of pulmonary resonance. The left border corresponds to about a finger's breadth from the left side of the superficial area; the right limit extends to the right margin of the sternum, or a little beyond it. The limitation of dulness to the right is, however, unreliable from the sounding-board properties of the sternum. Its vibrations can, to some extent, be limited by firmly pressing the hand against it during percussion, so as to lessen its capacity for vibration.

In the determination of the deep area the sense of resistance must, along with the pitch of the note, be taken into account. It is only in this way that an observer can realise when he has passed gradually from the situation of a solid structure to one containing air. Whilst, as a rule, the dulness of the liver and that of the heart pass insensibly into each other, it sometimes happens that a distinct increase of resistance, and of the intensity of the dulness, is experienced when passing from the hepatic to the cardiac region. This is to be accounted for by the comparative thinness of the liver, and its close relation to the stomach.

PERCUSSION IN DISEASE.

The area of cardiac dulness, both superficial and deep, may be *diminished* or *increased.*

It is *diminished* in those affections of the lungs and pleura which, by encroaching upon the heart, substitute resonance for dulness, as in vesicular emphysema and pneumothorax. It may

be diminished or lost in pneumo-pericardium (air in the cavity of the pericardium); and in tympanitic distension of the stomach there is an upward diminution of dulness.

It is *increased* in conditions involving enlargement of the heart—hypertrophy and dilatation, or both combined, the area of increased dulness varying according as the heart is involved as a whole, or as one or other of its ventricles is engaged.

Fig. 24.

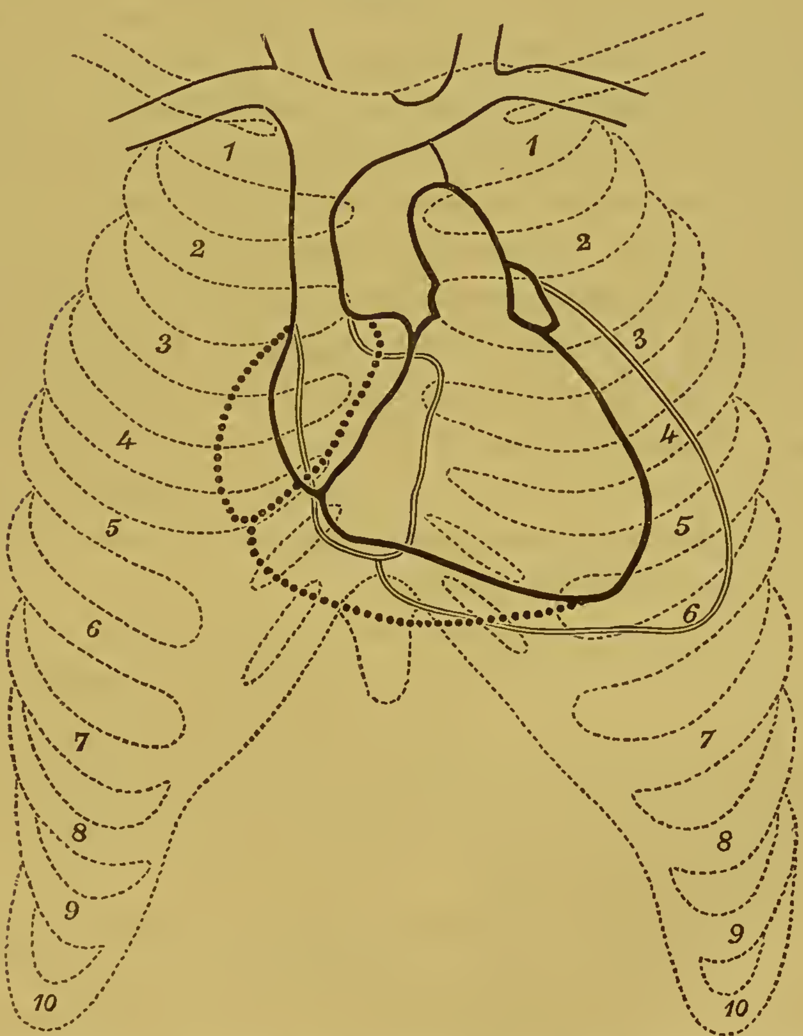


Diagram showing hypertrophy and dilatation of the right side and left side of the heart respectively. (From VON DUSCH.)

In hypertrophy of the left ventricle the heart tends to assume a conical shape, and the apex beat is displaced downwards and to the left, beating sometimes in the sixth, seventh, or even eighth interspace. The cardiac dulness is consequently increased, especially in length, and towards the left side. The important points to be observed in left ventricular hypertrophy with dilatation are, that the apex beat is markedly displaced, and that the upper limit of cardiac dulness is, without difficulty, ascertained to be higher than normal, as the enlarged heart has pushed aside the lung.

In hypertrophy of the right ventricle, which is generally accompanied by dilatation of the cavity, as well as enlargement of the right auricle, the heart tends to assume a somewhat square form ; it lies more horizontally, and an impulse beat is frequently to be observed in the epigastrium. The increase in dulness is chiefly in the transverse direction, passing to the right across the mid-sternal line, whilst the apex beat is scarcely lowered in position, but is displaced to the left. Dr. Walsh points out that increase in the area of dulness to the right, at the upper part of the cardiac region, indicates distension of the right auricle.

In general hypertrophy of the heart the area of dulness is increased in all directions—upwards, downwards, to the left, and to the right. In some instances the enlarged heart, although attaining a considerable size (*cor bovinum*), may not present any increase of percussion dulness from being covered by emphysematous lungs.

The area of dulness is also increased by effusion of fluid into the pericardial sac. Here, if the effusion be considerable, the shape of the præcordium is that of a blunted cone, the obtuse apex of which extends upwards to the second interspace, though it may, in extreme cases, reach to the first. The right

limit passes downwards from the third cartilage to the right of the sternum—in exceptional cases as far as the right mammillary line; the left limit may extend beyond the left mammillary line as far as the axillary border. In obscure cases the extension of dulness to the left of the apex beat is a most valuable sign. The increased area of dulness is more marked when the patient is examined standing or sitting up than when in the recumbent position. The first extension of dulness in pericardial effusion occurs at the base of the heart where the pericardium lies loosely about the great vessels; as the effusion increases, the pericardial sac becomes gradually distended until it assumes the shape described.

It is hardly necessary to point out that, in the several displacements of the heart due to extrinsic conditions, the area of dulness will vary in position and extent according to the position assumed by the heart in relation to the chest-wall.

CHAPTER IX.

AUSCULTATION OF THE HEART.

As in affections of the lungs so in affections of the heart, auscultation is employed *mediately* by means of the stethoscope, and *immediately* by direct application of the ear to the chest. Both methods have advantages and disadvantages as compared with each other which have been already referred to (p. 78). In the examination of the heart it is often of importance to auscultate immediately and mediately, so as to correct or confirm the impressions received from one method by the other. In some rare cases abnormal sounds (murmurs) may be heard on the direct application of the ear, which cannot be heard on listening with the stethoscope.

HEART-SOUNDS IN HEALTH.

On listening over the heart two sounds are heard followed by a pause. The relative proportion between these parts constitutes what is known as the *rhythm;* the complete revolution, made up of the different phases of activity and repose, is termed the *cardiac cycle.* The first sound, dull and prolonged in character, accompanies the impulse, and is termed the *systolic sound;* the second sound, sharp and flapping, follows the impulse, and is termed the *diastolic sound.* The former is best heard over the apex beat, the latter over the second intercostal space, close to both margins of the sternum.

Each sound represents similar conditions, affecting the right and left sides of the heart, which, occurring synchronously, produce only one audible ventricular and one audible arterial sound.

PHYSICAL CAUSE OF THE HEART-SOUNDS.

First Sound.—The causes of the first sound may be enumerated thus:—

1. The tension of the auriculo-ventricular valves and of the ventricular walls.
2. The striking of the apex against the chest wall.
3. The contraction of the heart muscle (*bruit musculaire*).
4. The rush of blood through the aortic and pulmonic orifices.

That the tension of the auriculo-ventricular valves contributes in a large degree to the causation of the first sound, is supported by the analogy between a stretched membrane, like the valves, thrown into sudden vibration and producing a sound resembling that which is emitted by a harp or violin string when brought from a state of relaxation to one of extreme tension. Furthermore, the intensity or loudness of the sound may be held to represent the difference between conditions of low and extreme tension. In the normal action of the heart the auriculo-ventricular valves float loosely in the ventricular cavities, when the blood is passing from the auricle into the ventricle. At the terminal period of diastole the valve curtains are floated upwards and bellied out in the direction of the auricles; the auricular contraction throws them into a condition of tension, but one which is unattended with sound; the forcible contraction of the ventricle driving the blood against the closed valves, and the simultaneous contraction of the papillary muscles produces the higher degree of tension, which *mainly* causes the first sound. If this explanation be correct, the first sound represents the difference between the early or *initial* tension and the *final* tension of the auriculo-ventricular valves. This theory affords an

intelligible explanation of the occasional diminution or disappearance of the first sound at the apex of the heart in aortic regurgitation.

Second Sound.—The second sound is caused by the closure and tension of the semilunar valves of the aorta and pulmonary arteries.

The position of the four orifices of the heart is indicated by a line drawn from the upper border of the third left chondrosternal articulation to the end of the right fourth interspace. The line crosses the orifices in the following order from left to right—pulmonary, aortic, mitral, and tricuspid. They lie in very close apposition to each other, a part of the four being covered by the bell of a stethoscope. But although they are in such close proximity, altered sounds in connection with these orifices are *conveyed* to different parts of the cardiac region, sound being conveyed in different directions, following the direction of the current of the blood, and *conducted* from the point of origination to the chest-wall by tendinous structures, muscular tissue, &c. For this reason we do not listen over the orifices of the heart for the sounds which are produced there, but at those centres or areas of the chest to which they are conducted. These areas, representing points where alterations of the sounds connected with each orifice are heard at their maximal point of intensity, may be defined thus:—

1. Mitral area, corresponds to region of apex beat.

2. Aortic area, to the second right costal cartilage (or interspace) close to sternum.

3. Tricuspid area, to the base of the xiphoid appendix, and left border of the sternum, corresponding to junction of fourth, fifth, and sixth left costal cartilages with it.

4. Pulmonary area, to second left costal cartilage (or interspace) close to sternum, or on a plane a little lower down.

ALTERATIONS IN THE HEART-SOUNDS.

The alterations in the heart-sounds to which attention will be first directed are—intensification, reduplication, alteration in character, and murmurs.

Intensification.—Both sounds of the heart are normally louder in the erect position, and during expiration and the respiratory pause when the lungs cover least of the heart's surface. They are also heard best where the thoracic parietes are thin, as in children and persons more or less emaciated, and in all conditions which increase the force of the heart—exercise, mental excitement, pyrexial conditions, and various neuroses, such as palpitation, exophthalmic goître, &c.

Intensification, or accentuation of the aortic second sound in the aortic area, is observed chiefly in two conditions—in hypertrophy of the left ventricle, and in dilatation of the ascending part of the arch of the aorta. The increase in tension of the aorta may be so great that, during the closure of the valves, a diastolic impulse, caused by the recoil of the blood from the valves, may be felt and seen.

Intensification, or accentuation of the pulmonary sound in the pulmonary area—the *cardiac sound of Skoda*—is observed in hypertrophy of the right ventricle, following obstruction to the pulmonary circulation. It is most frequently met with in mitral regurgitation and stenosis at the time when compensation is being carried on—that is, during the period when the walls of the right ventricle are undergoing such a degree of hypertrophy as will enable the ventricle to overcome the existing impediment to the flow of blood in the pulmonary circuit. In other conditions which lead to obstruction in the circulation in the lungs—such as emphysema, chronic asthma, &c.—the *sound of Skoda* will also be heard if there be co-existing right ventricular hypertrophy.

In determining the degree of accentuation of one of the second sounds at the base of the heart, it is well to listen over both arterial areas, so as to compare the intensified with the normal sound.

The accentuated sound will cease to be observed in conditions of failing compensation (where the right ventricle is undergoing fatty degeneration, or becomes weak and dilated), and when a leakage of blood takes place from the overloaded ventricle into the auricle. Thus, when tricuspid regurgitation is established in mitral disease the accentuated pulmonary sound is absent.

Weakening or *enfeeblement* of the sounds of the heart is observed in healthy persons who have a thick covering of soft parts, fat or muscle, on the chest.

In disease it may arise from simple debility or feebleness of the heart's action due to deficiency of food, depressing influences following a severe and prolonged illness ; from a dulling of the sounds, owing to the heart being overlapped by voluminous lungs as in emphysema ; or from the sounds being masked by adventitious sounds, such as the râles developed in diseases of the bronchial tubes.

REDUPLICATION OF THE HEART-SOUNDS.

The heart-sounds are said to be reduplicated or doubled when, instead of two sounds, four are heard—the systolic and diastolic sounds being each broken up into two parts. Where a distinct interval exists between the two elements of the doubled sound, it is said to be *reduplicated ;* where the two elements fuse together without any appreciable interval, the sound is said to be *divided.* This, however, is a distinction of little value, because in listening to a reduplicated sound it will be found that during certain beats of the heart the double character may become more or less indistinct, whilst in

succeeding beats it is well pronounced. If the single sound be likened to the syllable *tup*, the *reduplicated* sound would answer to *tup-tup*, the *divided* or subintrant sound to *turrup* (Gee).

Reduplication of the first sound is met with frequently in health. It cannot be associated with any special lesion of the valves of the heart, being observed in mitral and tricuspid disease and in the various forms of hypertrophy. It is of intermittent occurrence, and bears a close relation to the movements of respiration. The first sound, according to Potain, doubles at the end of expiration and at the beginning of inspiration, whilst the second sound doubles at the end of inspiration and the beginning of expiration.

Reduplication of the first sound is most probably due to a want of synchronism in the contraction of the ventricles and in the tension of the auriculo-ventricular valves of the two ventricles. The difficulty in accepting this view arises from the absence usually of a reduplicated second sound with a reduplicated first, as it is reasonable to assume that if the ventricles were asynchronous in their contraction, the diastolic closure of the aortic and pulmonic valves should likewise be asynchronous. Furthermore, certain cases have been observed where the first sound was tripled (*Trommelschlag*, or rat-tat-tat sound).

The theory as regards reduplicated first sound, which is supposed to harmonise with these conditions, is to refer it to non-synchronous tension of the individual segments of the auriculo-ventricular valves. There is still much obscurity in reference to the causation of this phenomenon. Possibly both explanations may be accepted, that where a double first sound is accompanied by a double second sound there is asynchronism in the contraction of the two ventricles ; where the first

sound alone is doubled there is asynchronism in the tension of the segments of the auriculo-ventricular valves.

A peculiar variety of double first sound is observed occasionally in hypertrophy of the left ventricle, associated usually with Bright's disease or arterio-sclerosis. One of the elements of the double sound is heard at the end of the pause immediately preceding the normal first sound, as it were interposed before it. This presystolic sound makes the action of the heart resemble, acoustically, the noise made by a galloping horse—hence the name given to it by Potain, the *bruit de galop*. At first Potain regarded the presystolic sound as due to the contraction of an hypertrophied left auricle, but subsequently he considered it to be caused by the sudden diastolic tension of the walls of a hypertrophied ventricle. *Bruit de galop* can be heard only in the situation of the apex beat.

Reduplication of the heart-sound heard over the aortic or pulmonary areas may be observed sometimes in apparently normal conditions, but much more frequently in disease. It generally occurs independently—that is, not associated with reduplication of the first sound. It is caused by a want of synchronism in the tension of the semilunar valves of the aorta and pulmonary artery. This asynchronism is most frequently associated with conditions which alter the relative degree of tension in the pulmonary and aortic systems, as in mitral stenosis and regurgitation. The amount of blood which reaches the aorta is reduced in quantity, whilst an increased amount is retained in the pulmonary vessels, so that the maximal degree of tension in the aorta and the pulmonary artery is reached at different times—hence asynchronism in the closure and tension of their respective valves.

It may be observed that reduplication of the second sound in mitral stenosis presents peculiarities not met with ordinarily

in reduplicated second sound. The double sound in mitral stenosis is best heard, not over the pulmonary area, but above the apex, over the body of the ventricle, and in close proximity to the situation of the mitral orifice. It possesses frequently more the character of a divided than of a reduplicated sound; it is usually heard only when the heart action is slow; and it is frequently replaced by a murmur, diastolic in time and audible at the *beginning* of the pause. Guttmann holds that reduplication of the second sound in mitral stenosis takes place at the mitral orifice; that the two sounds, apparently of pulmonic origin, are really component elements of a murmur which is developed at the mitral orifice whenever the heart's action is increased in force and frequency. A more satisfactory explanation is one which connects one of the elements of the double sound with the diastolic pulmonary sound, and the second element with the contraction of a hypertrophied left auricle (Johnston).

The triple beat of the heart—that is, a first sound followed by a double second sound—resembles the noise of a hammer rebounding on an anvil, or a postman's knock. It is termed the *bruit de rappel* (Bouillaud).

ALTERATIONS IN CHARACTER OF THE HEART-SOUNDS.

The heart-sounds are frequently altered in purity and become murmurish in character, especially in conditions involving loss of tone in the cardiac muscle, such as occurs not infrequently in persons who lead a sedentary life, and in those who appear to have from birth feeble circulatory power. Sometimes this quality of heart-sounds is associated with slight changes, especially to be noticed in the auriculo-ventricular valves, which lead to a beaded-like thickening of the edges of the valve flaps. The impure sound may occasionally

pass into a soft blowing sound when the heart beats forcibly and rapidly; but, on the other hand, a soft murmurish character of the first sound, such as may be developed in the atonic condition of the heart which follows a prolonged fever, is frequently replaced by a clear distinct sound when the heart's action is excited.

Heart sounds of a ringing metallic character are met with when the pericardium contains air (pneumo-pericardium), and occasionally in left pneumothorax. They are met with only in the latter when the heart is not much displaced.

The second aortic sound is frequently observed to have a booming or ringing character in atheromatous degeneration of the aorta, especially if accompanied by dilatation of the artery.

In very forcible contractions of the heart occurring after violent exercise, mental excitement, and not infrequently after a convulsive seizure, the first sound of the heart is observed to have a peculiar metallic jingle, which is attributed to the striking of the heart against the ribs.

Metallic Jingle.—The term *metallic jingle* was applied by Laennec to a sound heard when, on listening with the stethoscope, some bony point in close proximity to the site of auscultation is percussed. The sound exactly resembles that produced by tapping with the finger the back of the hand, with the palm pressed closely against the ear. It is not improbable that, as Dr. Gee suggests, the resonance of the meatus auditorius has much to do with the production of metallic jingle.

CARDIAC MURMURS.

All adventitious sounds, dependent on the movements of the heart, and either replacing or being superadded to the normal heart-sounds, are termed cardiac murmurs. They may

be developed either within the heart or outside it—hence the primary division of murmurs into endocardial, exocardial or pericardial, and vascular murmurs.

ENDOCARDIAL MURMURS.

A murmur is very generally termed a *bruit*, and it is often spoken of from its resemblance to the sound made by the escape of air through the nozzle of a bellows, under the name of *bruit de soufflet*, or bellows murmur. Like râles, murmurs are of the most varied character, being described as *bruit de lyre*, *b. de râpe*, *b. de scie*, *b. sibilant*, *b. de roucoulement*, &c., according to the sound which each resembles. They may be divided, as proposed by Bouillaud, according to their pitch, as they correspond to whispered words or letters, those of the highest pitch being represented by s-s-s-s prolonged, those next in pitch to r-r-r-r prolonged, those of low pitch by the whispered word *who*, and of a still graver tone, by the whispered word *awe*.

Endocardial murmurs are further divided into *organic*, and *inorganic* or *functional*. An organic murmur is one which is produced by some organic or structural change affecting an orifice of the heart. A murmur which involves no structural change, but which is associated with some irregularity in action, or want of tone, of the cardiac muscle, is termed an *inorganic* or *functional* murmur.

Functional murmurs are divisible into two classes—viz., *hæmic* and *dynamic*.

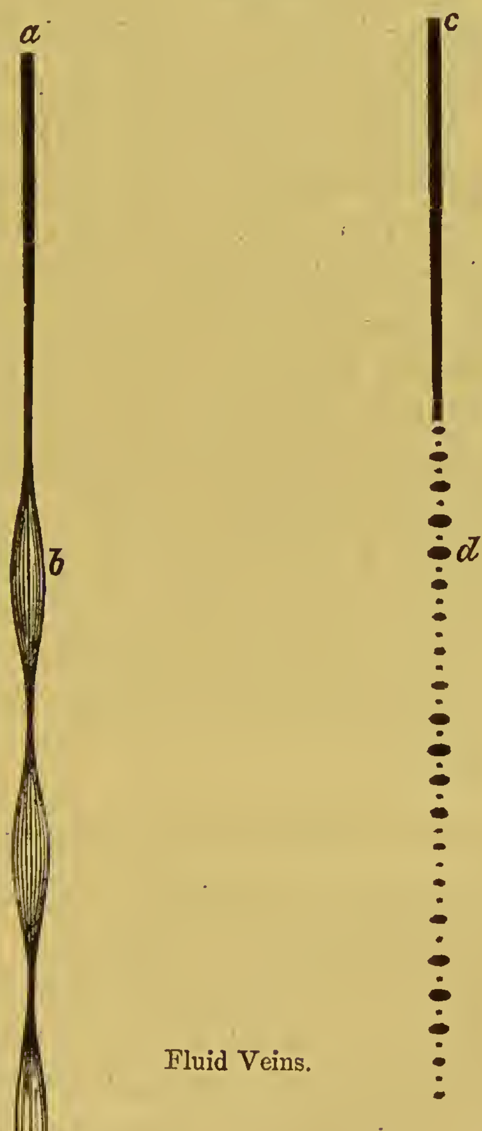
Hæmic murmurs are so called because they depend either upon a reduction in quantity of the circulating blood, or upon a reduction in the amount of its corpuscular constituents. When due to the former cause murmurs are termed *anæmic;* when to the latter, *spanæmic*. Both may be developed in the heart, arteries, or veins.

Dynamic murmurs are exclusively cardiac, and they are produced by conditions which lead to such a disturbance in the closure of the auriculo-ventricular valves as to produce regurgitation of a transient character. These conditions may be put under two heads—irregular or excessive contraction of the papillary muscles; or insufficient or imperfect contraction of these, or of a limited portion of the ventricular wall (Hayden).

There is still considerable difference of opinion as to the manner in which murmurs are produced, but the theory as to their origin which has found most general acceptance is a modification of that originally offered by Sir Dominic Corrigan. He wrote as follows:—"When an artery is pressed upon, the motion of the blood in the artery immediately beyond is no longer as before. A small stream is now rushing from a narrow orifice into a wider tube and continuing its way through the surrounding fluid. The rushing of fluid is combined with a trembling of the artery, and the sensation to the sense of hearing is the *bruit de soufflet.*" M. Chaveau formulates this theory in scientific terms by referring all murmurs, whether cardiac or vascular, to the sonorous vibrations of *fluid veins,* which are capable of being transferred to the surrounding fluid in which the vein may be produced and to the walls containing it. The character of the murmur depends upon the force exerted in producing the fluid veins, as well as upon the rapidity with which the vibrations succeed each other. The term *fluid vein* was applied by M. Savart to the jet which is produced when a liquid flows from a reservoir through a vertical or horizontal orifice. In the heart and arteries it is explained as due "*aux vibrations de la veine fluide intra-vasculaire, vibrations qui se produisent toujours quand le sang pénètre avec une force suffisante dans une partie réellement ou comparativement dilatée de l'appareil circulatoire.*"

The *fluid vein*, according to M. Savart, as observed when flowing from a circular orifice in the bottom of a vessel of water, consists of two parts, the one calm and transparent like a stem of crystal, or presenting the appearance of a solid rod, which obstructs vision and wets the finger when passed through

Fig. 25.



Fluid Veins.

Taken from Dr. Balfour. (Diseases of the Heart.)

it (part *a b*, fig. 25). This decreases in diameter till a point of maximal contraction is reached, *b*, when the second part is observed, consisting of a number of periodic swellings and contractions, of which the maximal diameter is always greater than that of the orifice. The swellings do not wet the finger when passed through them, nor obstruct vision. The nodal appearance is due to the liquid vein being no longer continuous but resolving itself into a series of liquid spherules, which, from their rapid succession, have an appearance of continuity, the separate drops of the fluid vein succeeding each other at regular intervals, and each drop changing its form in passing from point to point. Fig. 25 represents the fluid vein illuminated by an electric flash. The spherical drops, when first detached, are seen to have their long axis vertical; when left to their own molecular forces they tend to become spheres, and then, pendulum-like, seeking to return to rest, the contraction goes too far, and they become flattened spheroids, which again elongate vertically—hence the appearance of alternate swellings and contractions. It is, then, upon the motion of this fluid vein or vibrating axial current, developed with a certain amount of force when the blood passes from a narrow orifice into a large space beyond, that murmurs, cardiac and vascular, depend.

ORGANIC ENDOCARDIAL MURMURS.

The organic change at the orifice of the heart which produces a murmur, leads either to obstruction to the outflow of the blood, or, by causing imperfection of a valve, allows the blood to leak into the chamber situated behind it. Thus the two conditions affecting each orifice, which may exist separately or in combination, are obstruction or stenosis, and regurgitation or patency.

A murmur occurs at a particular time in the cardiac cycle, and the determination of this constitutes what is termed its rhythm. Murmurs which replace or are closely related to the first sound are termed *systolic;* those which replace or are closely related to the second sound are termed *diastolic.* Strictly speaking, the terms systolic and diastolic refer to the conditions of systole and diastole of the ventricles; and as the diastole of the ventricles occupy a much longer period of time than the second sound, a murmur may be heard at the commencement of diastole, when the second sound is heard, and when the murmur is, in reference to that sound, *diastolic;* and a murmur may also be heard at the end of diastole altogether unconnected with the second sound, but closely preceding the first—viz., the presystolic murmur. During diastole, the aorta and the auricles contract—the aorta at the commencement of the pause, the auricles at its termination; hence a murmur developed at the time of diastole will have a different rhythm according as it is produced during the elastic recoil of the aorta, or during the auricular systole.

For the sake of simplicity, we may tabulate the murmurs occurring at the orifices of the heart as follows:—

Mitral murmurs: Systolic, presystolic, and diastolic.

Aortic murmurs: Systolic and diastolic.

Tricuspid murmurs: Systolic, presystolic, and diastolic.

Pulmonary: Systolic and diastolic.

Before dwelling upon the value to be attached to each of these different murmurs, it is necessary to advert to some points in connection with the quality, intensity, and mode of propagation of cardiac murmurs.

Endocardial murmurs, as a rule, are soft and blowing in character, and systolic or diastolic in rhythm. The systolic murmurs are generally louder and more accentuated than the

diastolic, which are more prolonged and of a hissing or suction-like quality. Ordinarily there is no difficulty in recognising the rhythm of a murmur, as it can be accurately timed by noting its relation to the impulse beat which may be palpated at the time of auscultation. In cases, however, where the heart is very irregular in its action, extremely rapid and tumultuous, or so feeble that no impulse can be felt, the time of the murmur can be ascertained by comparing it with the pulse of the carotid artery, the throb of which may be taken as synchronous with that of the contraction of the ventricles. The radial pulse cannot be trusted for this purpose, as it is appreciably later than the impulse beat.

The intensity of murmurs varies considerably under a number of conditions. Sometimes they are so soft and faint that they cannot be heard until respiration is stopped; at other times they may be so loud and pronounced as to be audible to the patient himself and to the observer standing at a distance. They may be heard not alone over the heart but over the entire chest posteriorly as well as anteriorly. Such loud murmurs are almost invariably systolic. The intensity of a murmur is markedly influenced by the energy of the heart's contractions—hence frequently a murmur which is scarcely audible when the patient lies still and in the recumbent posture, becomes loud and distinctly marked when the action of the heart is excited by rapid walking, violent movements of the arms, &c. In some cases, however, murmurs which are audible when the patient reclines, become inaudible when he sits up or moves quickly about. This is specially the case with faint systolic tricuspid murmurs and in certain forms of mitral systolic murmurs, especially those which are developed after protracted fevers and in conditions of atonic weakness of the heart. Murmurs which have been loud and well pro-

nounced often disappear whenever the circulation is exceedingly feeble, as in degeneration of the heart, in asystole, or in the weakness of the organ which precedes death.

Murmurs are, generally speaking, not *materially* influenced by respiration, though it may be found that a systolic apex murmur is more distinct during inspiration than expiration; a tricuspid systolic murmur may become inaudible at the beginning of expiration. One of the peculiarities of a pulmonary systolic murmur of functional origin is that it becomes inaudible during inspiration. This point will be again referred to.

Pressure upon the heart sometimes affects the intensity of the murmur, and a procedure suggested by M. Gendrin is often of value in diagnosis. In many cases a murmur can be heard along with the sound with which it is associated; in others, the murmur completely replaces the sound when it is said to be a *substantive* or *substitutive* murmur. In those instances in which murmur and sound are present, if the ear be raised slightly from the disc of the stethoscope the sound becomes more audible and the murmur less so (Gendrin). Occasionally a systolic murmur can be produced by pressure with the stethoscope over the pulmonary area in the young.

With regard to the mode of propagation of murmurs it may be said that the same rules apply to murmurs as to the sounds of the heart—viz., that they are heard at their point of maximal intensity over that part of the chest which is nearest to the orifice at which they are generated. Murmurs developed at the mitral orifice are best heard over the mitral area; aortic murmurs at the aortic area; tricuspid at the tricuspid area; and pulmonary at the pulmonary area. The murmurs are propagated from their points of maximal intensity in different directions, not alone through the influence of the

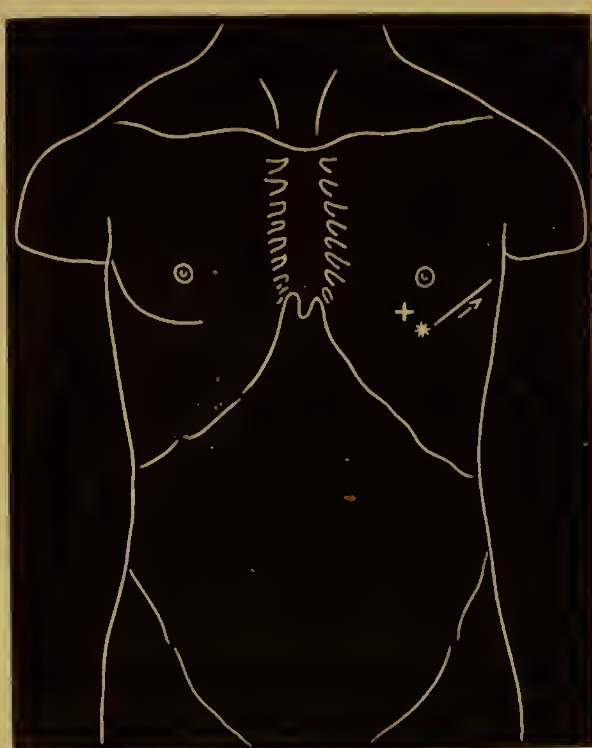
tissues subjacent to the various orifices, but also by the direction of the blood current, or, as it is termed, by convection. This will be referred to in describing the characters of mitral and aortic murmurs.

Thus it is seen that the diagnosis of a valvular lesion depends upon (1) the rhythm, (2) the point of maximal intensity, and (3) the mode of direction of a murmur.

MITRAL MURMURS.

The murmurs heard ordinarily over the mitral area are—the systolic, presystolic, and diastolic murmurs.

Fig. 26.



Outline figure showing point of maximal intensity and direction of propagation of systolic mitral murmur. From Byrom Bramwell.

Systolic mitral murmur is the symbol of mitral regurgitation either of organic or of functional origin. When exaggerated in

intensity it is propagated to the left of the impulse beat along the anterior axillary fold, and it may be heard in the inter-scapular region and at the inferior angle of the left scapula. It is frequently accompanied by thrill, and is attended by an accentuation of the pulmonary second sound (cardiac sound of Skoda).

Occasionally a systolic murmur of mitral reflux is heard best at a point considerably higher than the apex beat, over the third left cartilage, or even in the second left intercostal space close to the margin of the sternum. This variety of mitral murmur is known as Naunyn's murmur, from the physician who specially called attention to it. The explanation given by him of the mode of its production is that in some cases of mitral regurgitation the left auricle becomes hypertrophied, and the enlarged and thickened left auricular appendix comes to lie into close contact with the chest wall. Although this view receives the support of Dr. Balfour, it is, however, a matter of some doubt whether, except in wasting disease of the upper part of the left lung, the left auricle, or its appendix, could reach the surface of the chest. It is more probable that the murmur specially described by Naunyn is due to such alterations in the mitral valve as determine simply by convection the development of murmur audible in the situation of the left auricular appendix.

The murmur of organic mitral regurgitation is one which is liable to variations as regards its existence and intensity, disappearing and re-appearing inexplicably; sometimes loud and well-defined, at other times but faintly audible.

In many cases mitral regurgitation takes place and is attended with murmur, although no organic change exists in the valve segments. The condition with which the murmur is associated is one of relative incompetence of the valve,

existing in dilatation of the left ventricle, and in degenerative hypertrophy of it. A number of observers point out that it may occur from over-muscular exertion, as in campaigning, constantly ascending ladders, &c. (Peacock, Leitz, Forgeb, Fräntzel). It may also be produced by the development of ante-mortem clots in the left side of the heart.

When mitral regurgitant murmur exists permanently, it induces hypertrophy and dilatation of the left cavities of the heart, congestion of the lungs, and, finally, hypertrophy and dilatation of the right cavities.

The pulse in mitral regurgitation is usually compressible, thready, and irregular.

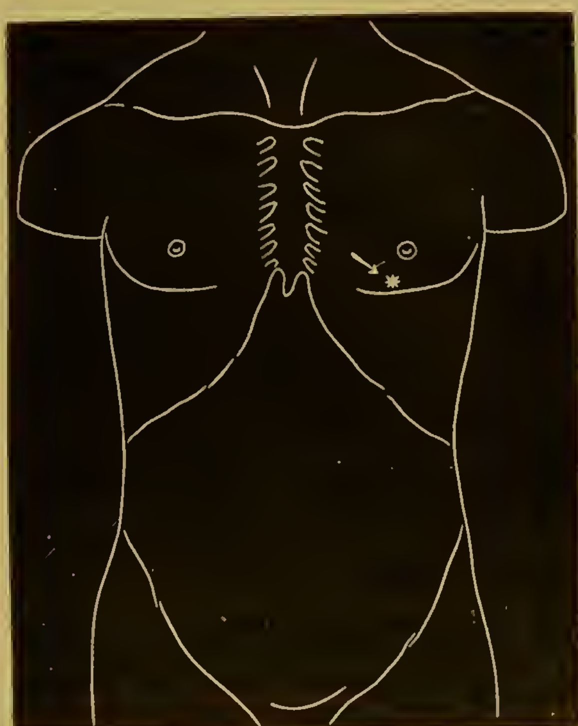
Fig. 27.

Mitral Regurgitation. From Byrom Bramwell.

Mitral Obstruction or Stenosis.—This condition is indicated by the existence of a murmur, which is usually heard at the end of the pause immediately preceding the first sound of the heart—hence it is termed *presystolic.* It is produced by the contraction of the left auricle, sending the blood with considerable force through the narrowed auriculo-ventricular orifice—hence the appropriateness of the name given to it by Dr. Gairdner—viz., auricular systolic. It is a murmur of vibratile character, resembling in sound the symbols rrb, voot, or rŭp. It is usually best heard at a point slightly internal to the apex beat, occasionally with great distinctness to the *left* of the apex, on a line with the nipple. It is frequently

followed by the systolic murmur of mitral regurgitation, whilst, at the base of the heart, the *bruit de rappel* (reduplicated second sound) is usually to be heard. A thrill, prolonged and presystolic, in time, generally accompanies the murmur. When non-existent, it may be developed by getting the patient to make some muscular effort—to sit up, and lean forwards, and to the left.

Fig. 28.



Outline figure showing point of maximal intensity and direction of propagation of presystolic mitral murmur. From BYROM BRAMWELL.

Presystolic murmur may be terminated by a remarkably sharp clicking first sound, due, probably, to the tension and vibrations of the greatly thickened, but smooth and flexible mitral curtains. From the comparatively small amount of blood which reaches the left ventricle, the initial tension of

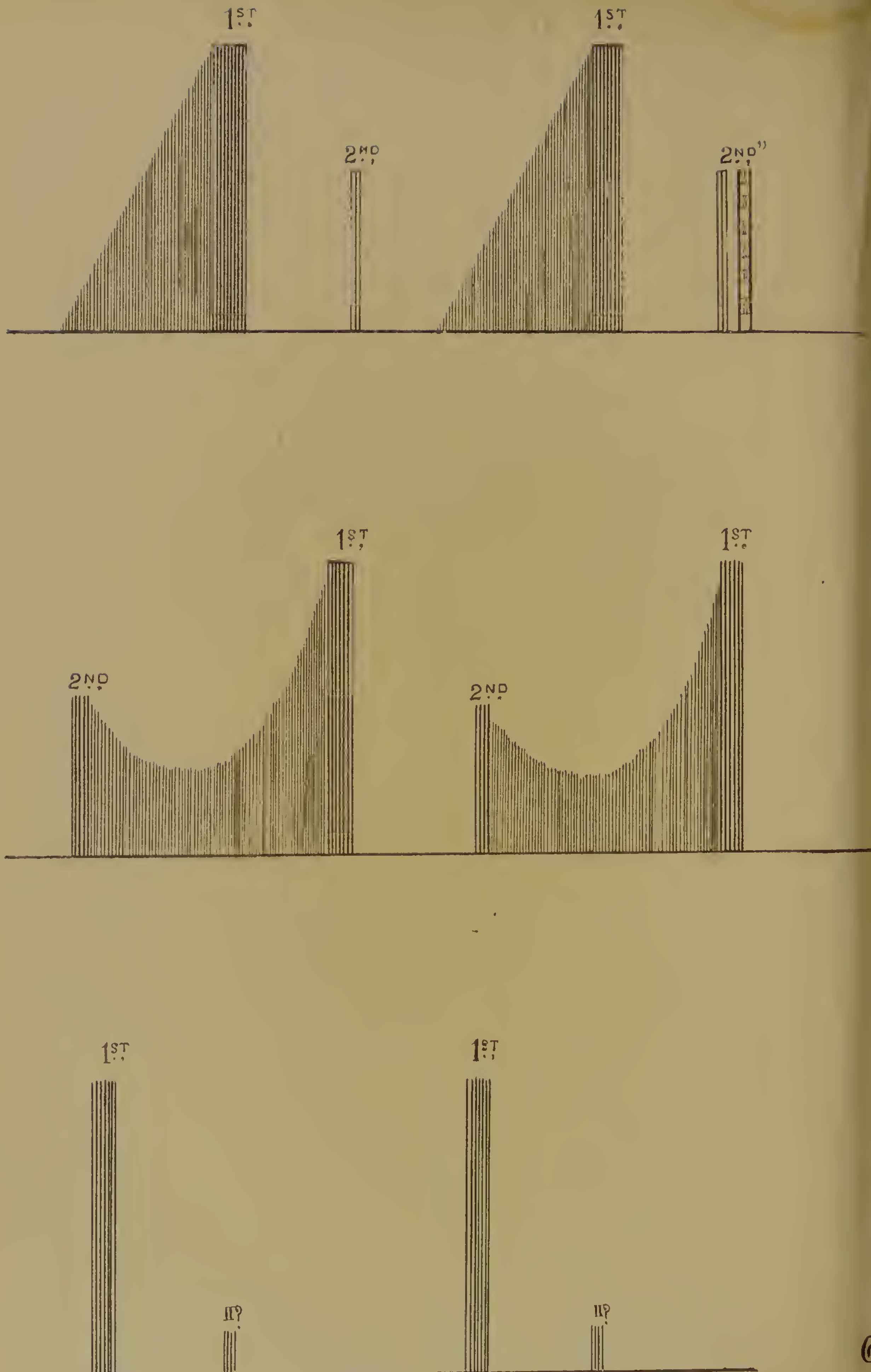
the mitral valves must be small, so that if the ventricle contract with vigour, the difference between this and the final tension is considerable—hence the intensification of the first sound (see p. 153). The second aortic sound is, in mitral stenosis, greatly lessened at the apex of the heart, and in some cases it may be entirely absent (Broadbent). This is due to decrease of tension in the aorta, from insufficient filling of the left ventricle.

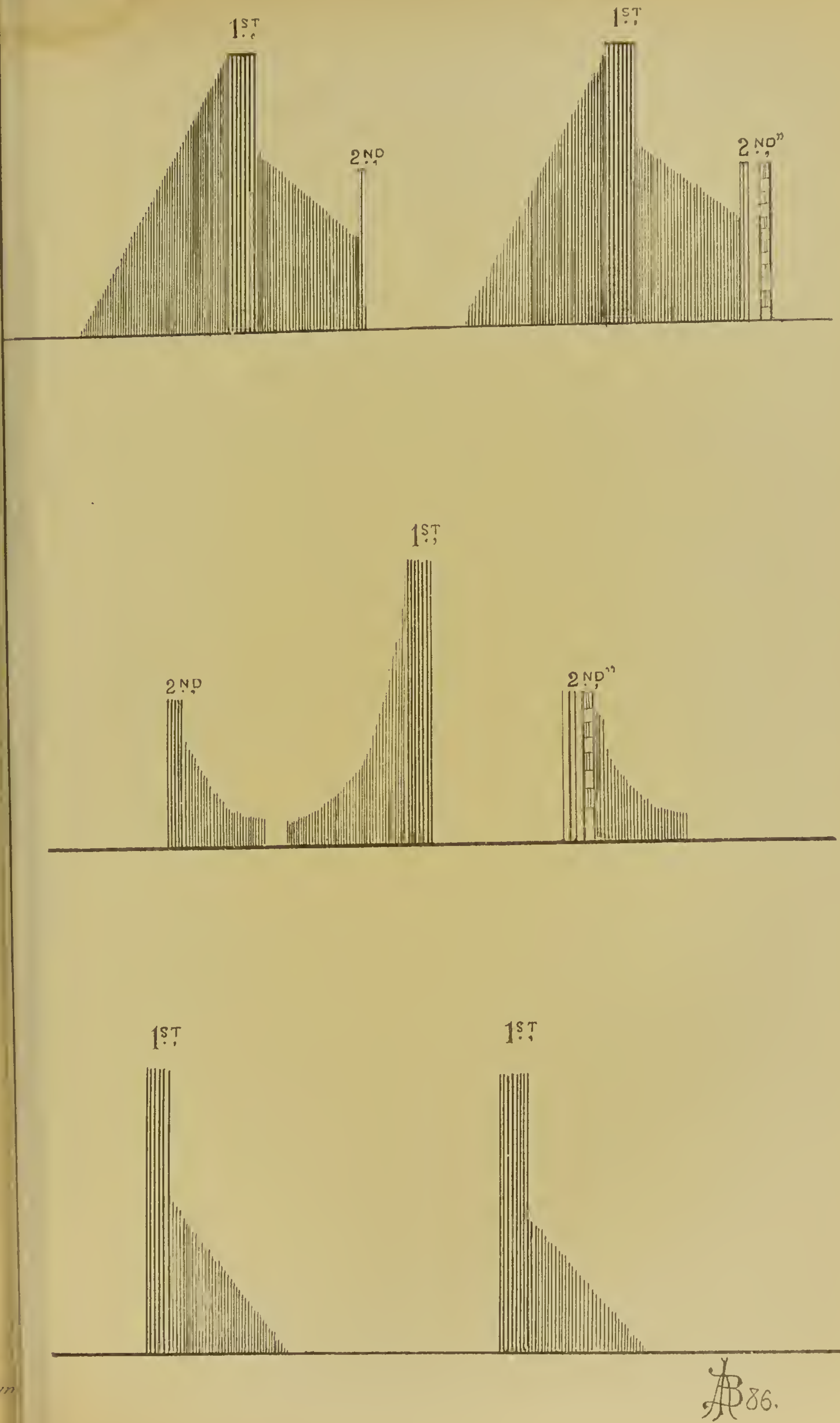
In a certain proportion of cases of mitral stenosis a murmur can be heard, of diastolic rhythm, or, rather, post-diastolic, that is, occurring at the *beginning* of the pause, immediately after the second sound, and *apparently* connected with it. This murmur may run through the entire pause, terminating in a presystolic murmur. It may be separated from the presystolic murmur by an appreciable interval, or it may exist without presystolic murmur. There is still some difference of opinion as to the mechanism of diastolic, or post-diastolic, murmur. It, probably, is due to the active dilatation of the left ventricle, forming audible fluid veins at the commencement of the pause.

It has been shown that the ventricle dilates under a negative pressure of 23·5 millimetres of mercury (the "vacuité post-systolique" of Marey), so that a sufficient amount of suction force exists to produce a murmur. The distinction between the causation of diastolic and presystolic murmur lies in the former being ventricular diastolic, whilst the latter is auricular systolic.

Mitral stenosis is attended with physical signs, which may be tabulated as follows:—

1. Presystolic murmur, terminated by sharp clicking first sound.
2. Presystolic murmur, followed by systolic murmur.


1ST
2ND
1ST
2ND"
2ND
1ST
2ND
1ST
1ST
II?
1ST
II?


1ST
2ND
1ST
2ND"
1ST
2ND
2ND"
1ST
1ST
AB 86.

3. Diastolic murmur, which occupies the entire of the long pause, or is broken up into post-diastolic and presystolic murmurs.
4. Sharp accentuated first sound, unattended with murmur; feeble development, or extinction, of second sound.
5. Presystolic murmur, with rough systolic murmur; best heard over pulmonary area.

A double second sound is usually audible.

The plates, kindly prepared for me by Professor Birmingham, illustrate the different conditions referred to.

It should be borne in mind that presystolic murmur may be simulated by a double first sound, or by a murmur of pericarditis, from the exceptional occurrence of a single pericardial friction murmur limited to the site of apex pulsation, and produced immediately preceding the impulse.

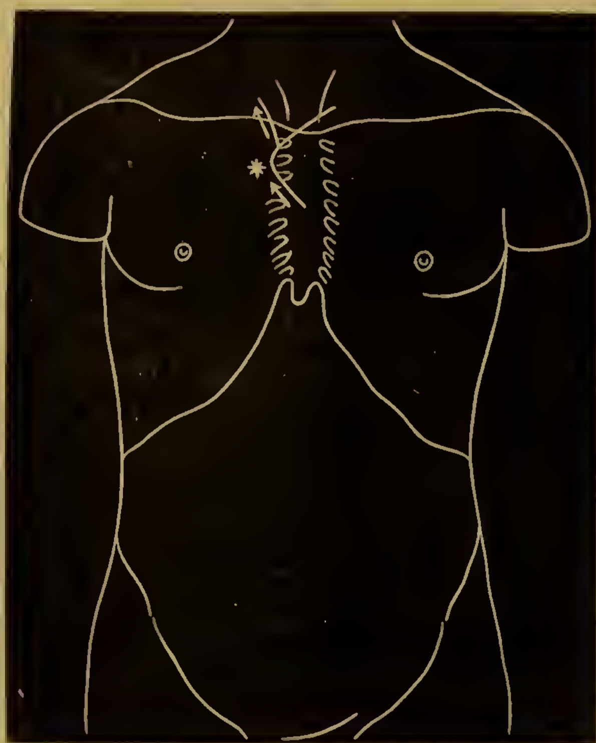
The use of the term post-diastolic as a qualification for murmur may be defended upon the understanding that the names systolic and diastolic refer respectively to the first and second sounds of the heart. If this be conceded, post-diastolic accurately defines the precise position of the murmur in the cardiac cycle.

AORTIC MURMURS.

Aortic Obstruction.—A systolic murmur, heard at its maximal point of intensity, over the second right interspace, is indicative of aortic obstruction. It may also exist in atheromatous change involving the commencement of the arch of the aorta, and exceptionally in aortic aneurysm. The murmur is usually loud and harsh, sometimes trumpet-toned in character, and audible in the vessels of the neck. It may be accompanied by thrill, perceptible over the upper part of the sternum.

The systolic murmur of aortic obstruction, when met with in the aged, is often associated with fatty degeneration of the left ventricle—hence it is regarded as a sign of a grave condition of disease (Stokes).

Fig. 29.



Outline figure showing point of maximal intensity and direction of propagation of systolic aortic murmur. From Byrom Bramwell.

Aortic obstruction in the young gives rise to simple hypertrophy of the left ventricle. In extreme cases there is a weakening of apex pulsation, and occasionally the cardiac impulse is entirely absent. This is accounted for by equalisation of pressure at the aortic orifice and within the ventricle, so that there is, during systole, an absence of recoil. (See Gutbrod-Skoda Theory of the cause of an impulse beat, page 128.)

The pulse in aortic obstruction is usually small in volume, but regular. If there be considerable hypertrophy of the left ventricle, it may be full, regular, and bounding.

Fig. 30.

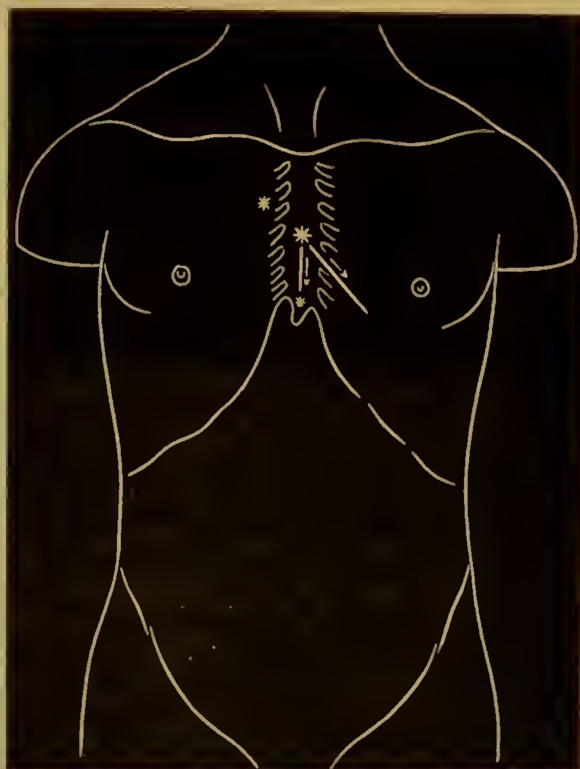
Aortic Stenosis. From BYROM BRAMWELL.

Aortic Regurgitation.—A murmur, diastolic in time, replacing or following the second sound, and heard best over the aortic area, indicates aortic patency or regurgitation. This murmur is usually associated with the systolic murmur of aortic obstruction, and the two murmurs produce a sound resembling that of the sawing of wood—hence termed *bruit de scie.* The murmur is often distinctly hissing, suction-like, or cooing in character.

The murmur of aortic patency is frequently heard on a much lower level than the second right interspace. It may be audible in its most marked degree at mid-sternum, or even at the base of the ensiform cartilage. It is conveyed downwards by the regurgitating stream of blood, the direction of convection being favoured by the sounding-board properties of the sternum. In rare cases the murmur may be heard best in the third left interspace, or at the apex of the heart. In the former, the heart will be found to have undergone considerable displacement to the left side, due to hypertrophy and dilatation of the left chambers followed by enlargement of the right; in the latter, the murmur is also associated with displacement of the heart, though the direction of the regur-

gitating stream of blood, influenced by the segment of the aortic valves which is specially involved in the lesion, may possibly aid in the propagation downwards of the murmur (Foster).

Fig. 31.



Outline figure showing point of maximal intensity and direction of propagation of diastolic aortic murmur. From BYROM BRAMWELL.

It is sometimes so loud as to be capable of being heard over the entire chest, and to be perceptible to the patient himself. When well-pronounced it is audible in the left inter-scapular region.

The diastolic murmur of aortic regurgitation may exist with an unaltered first sound, and it may replace or simply follow the second sound. In the early stage of aortic valvulitis, it is usually present without a systolic murmur, and in

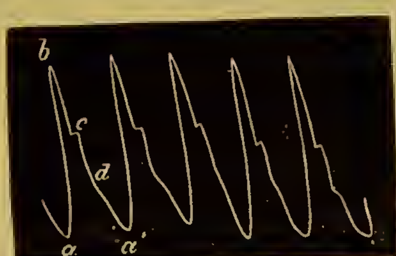
aneurysmal dilatation of the ascending part of the arch a like condition obtains.

Thrill, diastolic in rhythm, and perceptible over the upper part of the sternum and second right interspace, is not infrequently present. Almost invariably a *frémissement cataire* can be felt on pressure over the subclavian arteries.

A peculiarity with regard to the sounds in the carotid arteries is to be noted in aortic patency. Usually the first sound is replaced by a hoarse murmur, whilst there is an absence of the second sound, or replacement of it by a diastolic murmur. Where there is no murmur of aortic obstruction in conjunction with that of regurgitation, there is a single systolic sound to be heard over the carotids.

The occurrence of diastolic murmur in the arteries in aortic regurgitation, which is not produced artificially, is rare; the peculiar pulse met with in this disease (water-hammer pulse, pulse of unfilled arteries) has been already referred to (p. 134).

Fig. 32.



Aortic Regurgitation.

The prolonged existence of aortic regurgitation invariably leads to dilatation and hypertrophy of the left ventricle. Occasionally the dilatation of the ventricle is so great as to produce a relative incompetence of the mitral valve, indicated by a mitral systolic murmur. This murmur is termed *the murmur of secondary mitral incompetency.*

Traube has called attention to a weakening or absence of the first sound at the apex in cases of advanced aortic regurgitation. This condition is intelligible if the first sound be taken as representing the difference between the initial and final tensions of the auriculo-ventricular valves. In well-marked aortic regurgitation the ventricle has received almost its normal quantity of blood before the auricular contraction, owing to the amount which has been drained into it from the aorta. Consequently the segments of the mitral valve, during the contraction of the auricle, must have their tension greatly increased (presystolic or initial tension), so that the difference between this and the tension produced by the ventricular systole (systolic or final) is so decreased that the sound produced is faint or entirely inaudible.

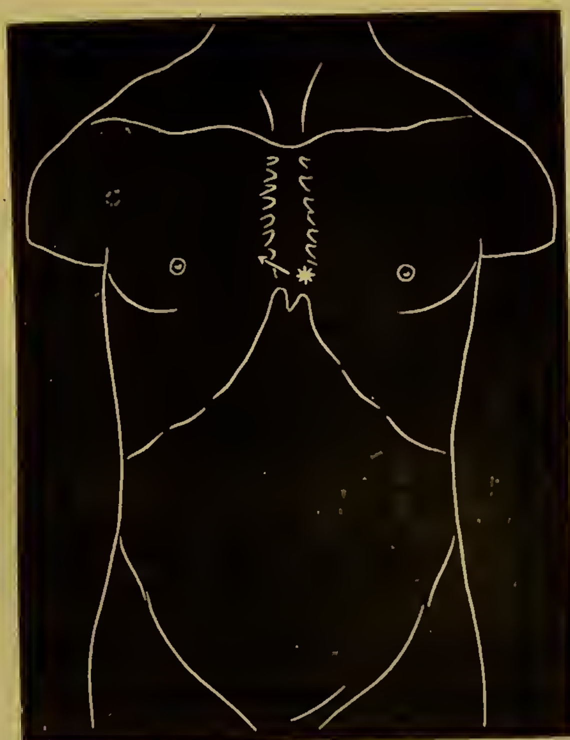
TRICUSPID MURMURS.

A systolic murmur heard best over the lower part of the sternum, corresponding to the base of the xiphoid appendix, and the junction of the fourth, fifth, and sixth left costal cartilages with the sternum, and propagated in a direction slightly upwards, in the direction of the point where the right auricular appendix lies in contact with the chest wall (the third right costal cartilage), indicates tricuspid regurgitation. This murmur is soft and blowing in character, and is accompanied usually by double pulsation in the jugular veins, or by *the sound of the jugular valves* (Bamberger). The second pulmonary sound is lessened in intensity.

Tricuspid systolic murmur is of rare occurrence, and it is most frequently associated with relative incompetency of the valve arising from the dilatation of the right ventricle which follows impeded circulation through the lungs, either from emphysema, or disease affecting the left side of the heart,

especially mitral stenosis or regurgitation. It may, however, arise from tricuspid valvulitis, either chronic or acute in form. Organic disease of the tricuspid valve is usually found in acute diphtheritic endocarditis.

Fig. 33.



Outline figure showing point of maximal intensity and direction of propagation of tricuspid systolic murmur. From Byrom Bramwell.

Most cases of tricuspid regurgitation are probably unattended with murmur, as the dilated and weakened ventricle does not contract with sufficient force to produce one.

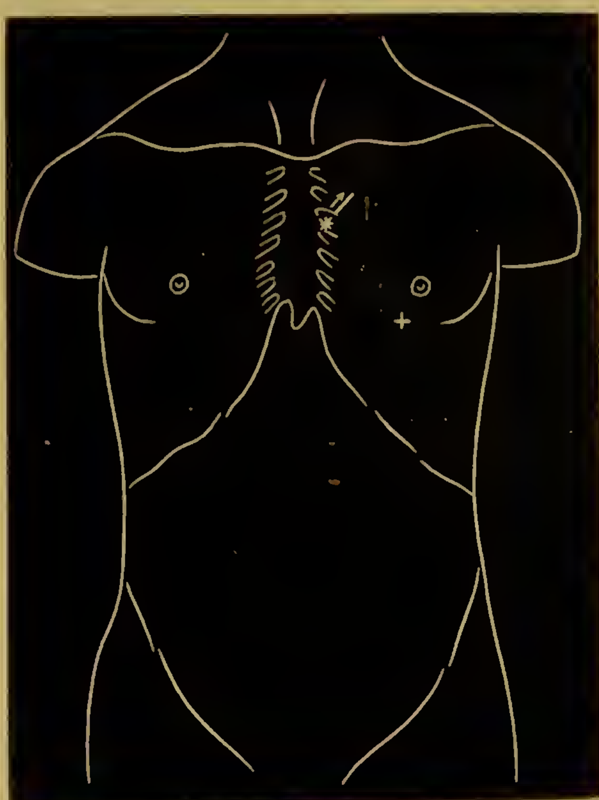
In extremely rare cases, a presystolic murmur is heard at its maximal point of intensity over an area defined by Dr. Fenwick as follows:—Right angled, triangular in shape; perpendicular, right border of sternum and ensiform cartilage from

the fourth right chondrosternal joint downwards; base, horizontal line drawn from tip of ensiform cartilage to the sixth left chondrosternal joint; hypotenuse, a line drawn from fourth right chondrosternal joint to sixth left chondrosternal joint. Presystolic tricuspid murmur is invariably associated with mitral stenosis; the disease of the left auriculo-ventricular orifice leads to sclerotic endocarditis of the right side which eventuates in tricuspid stenosis.

PULMONARY MURMURS.

A systolic murmur heard best over the second or third left

Fig. 34.



Outline figure showing point of maximal intensity and direction of propagation of pulmonary systolic murmur. From Byrom Bramwell.

interspace close to the sternum, or over the cartilage of the third rib, indicates obstructive disease in the pulmonary artery. The murmur is usually accompanied by thrill, and is attended with an hypertrophied condition of the right ventricle.

A diastolic murmur, heard best in the same situation, indicates pulmonary incompetence, or regurgitation. The murmur is transmitted downwards along the sternum, and is accompanied by a diastolic thrill.

Organic murmurs in the pulmonary artery are of such rare occurrence that it is needless to dwell further upon their characteristics.

SIGNS OF VALVULAR LESIONS.

For the sake of simplicity the signs of the various valvular affections of the heart may be tabulated as follows:—

Systolic murmur signifies regurgitation at auriculo-ventricular orifices; obstruction at arterial orifices.

Diastolic murmur signifies obstruction at auriculo-ventricular orifices; regurgitation at arterial orifices.

1. *Mitral Regurgitation.*—Systolic apex murmur propagated towards the axilla; accentuated pulmonary second sound; secondary hypertrophy and dilatation of right ventricle; systolic apex thrill.

2. *Mitral Stenosis.*—Presystolic or diastolic apex murmur; accentuated pulmonary or doubled second sound; secondary hypertrophy and dilatation of right ventricle; presystolic apex thrill.

3. *Aortic Regurgitation.*—Diastolic aortic murmur heard best over aortic area and at mid-sternum. First aortic sound usually replaced by murmur, so that a *bruit de scie* can be heard over upper part of sternum. Systolic hoarse murmur

in carotids, with suppressed second sound. Visible pulsation of arteries, especially those in the neck. *Frémissement cataire* over sternum and subclavian arteries. The pulse of unfilled arteries. Hypertrophy and dilatation of left ventricle, with marked displacement of apex beat.

4. *Aortic Stenosis.*—Systolic murmur, best heard over aortic area and upper part of sternum, and transmissible into the vessels in the neck. Systolic basic thrill. Simple hypertrophy of left ventricle, so that the sound produced is feeble or entirely inaudible.

5. *Tricuspid Regurgitation.*—Systolic murmur audible at lower part of sternum, transmitted slightly upwards, and to the right, and accompanied by double pulsation in the jugular veins. Enfeeblement of pulmonary second sound.

6. *Tricuspid Stenosis.*—Presystolic murmur heard best over tricuspid area. Signs of mitral stenosis co-existent.

7. *Pulmonary Regurgitation.*—Diastolic murmur heard best over pulmonary area, and transmitted downwards along the sternum. Hypertrophy and dilatation of right ventricle.

8. *Pulmonary Stenosis.*—Systolic murmur heard best over pulmonary area. Hypertrophy of right ventricle.

Pulmonary stenosis and regurgitation usually occur combined; they are almost invariably of congenital origin.

INORGANIC OR FUNCTIONAL MURMURS.

The division of inorganic murmurs into hæmic and dynamic has been already referred to. There remain to be discussed points in connection with the modes of production, sites of development, and general characters of inorganic murmurs.

Purely hæmic murmurs—that is, those which are due solely to diminution in the quantity or quality of the blood—are produced only at the arterial orifices of the heart, and in the

great venous trunks in the thorax and the root of the neck (*bruit de diable*). The last-named sign will be described in the section on venous murmurs.

Hæmic vascular murmurs were localised by Hope in the aorta, and his dictum in reference to a functional murmur was for a long time accepted—viz., basic in seat, systolic in time, and developed in the aorta. Hughes, however, directed attention to its frequent occurrence in the pulmonary artery; so that now a hæmic murmur is found by experience to be located at both arterial orifices, and is always systolic in rhythm.

The mode of production of the murmur is thus explained:—The blood-vessels generally, and the heart and its orifices, adapt themselves to the oligæmia and become proportionately diminished in size, with two exceptions. The exceptions are—(1) The aorta and pulmonary artery, which, owing to the absence of muscular tissue (contractile element) and preponderance of elastic tissue in their walls, cannot alter their capacity proportionately to the current passing through them. (2) The venæ innominatæ, which are kept permanently distended owing to the inflexions of the deep cervical fascia. We have consequently a condition developed which is favourable for the production of fluid veins in the aorta and pulmonary artery. The blood passes from each ventricle into a chamber which is relatively dilated, hence the production of murmur. Chauveau points out that in cases of anæmia, where a hæmic murmur exists, the diastolic pressure on the valves of the aorta and pulmonary artery is diminished, and as the systolic flow of blood into the arteries meets with less resistance than normal, the blood-current becomes swift—a condition also favourable in the production of murmur.

Whether or not corpuscular friction—that is, friction of the blood corpuscles against each other and against the arterial

orifices—constitutes a factor in the production of a hæmic murmur, is a matter of doubt. The observations of Chauveau* and Marey go to show that the hæmic murmur is materially influenced by increase in the rapidity of the current as well as in its force. The rate of movement and force of the blood-current are, however, conditions which influence the vibrations of a fluid vein, and it is probable, notwithstanding the authority of Hayden,† that this alone causes murmur.

Functional Aortic Murmur.—Functional murmur in the aorta is soft and blowing in character, and it is not transmissible into the vessels of the neck. When heard in the carotid the murmur is the result of pressure on the vessel.

It is right to point out that at present the weight of authority is rather against the view that hæmic arterial murmur exists in the aorta, many physicians of large clinical experience holding that what has hitherto been described as an arterial murmur present in the aorta in anæmia is really developed at the tricuspid orifice, and represents tricuspid regurgitation. This view will be discussed when dealing with dynamic murmurs.

Functional Pulmonary Murmur.—Functional murmur in the pulmonary artery needs some comment, as it is met with not only in anæmia but in conditions which do not involve any change either in the quality or the quantity of the blood.

Whilst murmurs in the pulmonary artery, as a result of organic disease, are the rarest signs met with in cardiac pathology, a systolic pulmonary murmur of functional origin is frequently met with. The pulmonary area, the space between the second and third ribs to the left of the sternum,

* Nouvelles Recherches Experimentales sur les Mouvements et les Bruits Normaux du Cœur envisagés au point de vue de la Physiologie Médicale. Paris, 1856. Archives Générales de Médecine, par le Dr. Parrot. Août, 1866.

† Diseases of the Heart and Aorta, p. 248.

has been termed the region of romance, from the various views which have been urged with regard to the origin and causation of murmurs having their maximal point of intensity in this situation. The points which will be specially dwelt upon in reference to this murmur are its character, the signs which simulate it, the conditions under which it is met with, and the probable mode of its production.*

Characters of the Murmur.—It is systolic in time, heard at its maximal point of intensity in the second left intercostal space close to the sternum, is not transmissible upwards in the direction of the left subclavian artery, or downwards over the ventriculum cordis. It is usually of a grating character, except when dependent on anæmia, when it is soft and blowing. It seems to be developed close to the ear, is frequently accompanied by a basic impulse, and closely resembles, but for its single character, a murmur of attrition. It varies considerably in intensity, and is, almost in every instance, markedly influenced by the respiratory movements. Whilst it is fairly pronounced during ordinary inspirations, it usually disappears at the acme of a forcible inspiration, its return during three or four succeeding quiet respiratory movements being one of gradual progression. The murmur is sometimes followed by a double second sound; more frequently its subsidence appears to so alter the cardiac rhythm as to produce the reduplication. It is heard best in the horizontal posture, being frequently inaudible in the vertical one. Whilst it is sometimes attended with signs of bronchitis in the upper lobe of the left lung, and sometimes in that of both lungs, it often exists independently of this condition; its presence is, how-

* The points noted in reference to functional pulmonary murmurs are mainly taken from a paper on this subject published by the author in the Dublin Journal of Medical Science, September, 1881.

ever, almost invariably associated with feeble respiratory movements. In some cases where the murmur is audible when the patient is sitting up, a brisk movement of the arms causes it to disappear.

Signs which simulate it.—The three conditions which are likely to give rise to errors of diagnosis in relation to pulmonary murmur are—limited dry pericarditis, left subclavian murmur, and the variety of mitral murmur described by Naunyn. Firstly, with regard to pericarditis, it may be remarked that probably more instances of error are met with in connection with the supposed existence of this lesion than with any other. The occasional extreme harshness or grating character of pulmonary murmur, its proximity to the ear, the presence of a thrill appreciable to the touch over that part of the heart where the signs of pericarditis are first developed, and the frequent occurrence of the murmur in cases of rheumatism, may account for the mistaken diagnosis of limited dry pericarditis. It is needless to recapitulate the peculiarities of pulmonary murmur, already dwelt upon, which enable us to attach the correct value to the sign. It is sufficient to point out, in relation to the error in question, the single character of the murmur, its localisation, its duration, the absence of all signs of pericardial effusion, and its existence without any rise in the temperature.

Murmur in the left subclavian artery may, from its proximity to the trunk of the pulmonary artery, simulate a murmur developed in the latter. The direction of transmission of a subclavian murmur, its association with tubercular or other disease of the apex of the lung, its occurrence in a certain class of mechanics, and the influence which the position of the arm exercises on its intensity, are points which should aid us in making the distinctive diagnosis. It may be remarked

that pulmonary murmur is, as a rule, limited to a small area, and is not heard under the left sterno-clavicular articulation or along the clavicle.

The systolic mitral murmur which is to be heard at its maximal degree of intensity in the second left intercostal space, one or two inches from the margin of the sternum, is likely to be mistaken for a murmur in the pulmonary artery. There is no doubt but that a murmur of mitral reflex, heard best over the situation of the left auricular appendix, is occasionally met with. The peculiar features of this murmur have been already referred to (p. 169), when dealing with Naunyn's murmur.

The important distinctive points to note with regard to Naunyn's murmur are:—It has not the grating or thrilling character of the pulmonary systolic murmur, it is not heard close to the sternum immediately over the site of the pulmonary artery, and it is not influenced by position or by the respiratory function.

Conditions under which it is met with.—Pulmonary functional murmur is sometimes heard when the upper part of left lung is contracted or consolidated as a result of phthisical disease or chronic pneumonia. The contracted or condensed pulmonary tissue compresses and constricts either the main trunk of the artery or one of its principal divisions, so that the passage of the blood is attended with murmur (Immermann). In other cases, the base of the heart being uncovered, owing to retraction of the lung, the pulmonary artery lies in direct contact with the front of the chest wall; the antero-posterior diameter of the heart being increased at each systole is thrust against the ribs and flattened, and murmur is produced during the onward current of the blood (Quincke).

In the paper referred to (see note, p. 185) the other con-

ditions under which a functional murmur in the pulmonary artery is met are given in order of frequency, as follows:—

(*a*) Acute articular rheumatism.

(*b*) Enteric fever.

(*c*) Fevers where there is great prostration and a tendency to profuse sweating.

(*d*) Bronchitis or œdema of the upper lobe of one or both lungs.

(*e*) Nervous diseases, such as paraplegia from myelitis, tubercular meningitis, or in a debilitated state of the system generally associated with hysteria or hypochondriasis.

(*f*) Cases where, as from extreme distension of the cavity of the peritoneum, the diaphragm is subjected to great pressure upwards.

(*g*) Trivial affections, such as diarrhœa, dyspepsia, &c., especially where there exists a tendency to the paralytic thorax. Here it is usually met with in young and imperfectly-nourished adults, and occurs more frequently in females than in males.

From the various conditions under which the murmur occurs it cannot be regarded as a sign of any special disease. It is in most cases of temporary duration, and it may occasionally be met with in a state of apparent health.

Mode of production of the Murmur.—Reference has been made to the causation of the murmur from pressure of a contracted or solidified lung against the main trunk or one of the principal branches of the pulmonary artery, and also in the case of flattening of the vessel itself against the chest wall. In the other conditions of its occurrence, its causation is by no means clear. It is assumed that the dictum of Chauveau, based upon his experiments and those of Savart, with regard to

the mode of production of *bruit de soufflé*, holds good for all murmurs save those of attrition. It has then to be ascertained what the conditions are in the pulmonary system for the formation of this *veine fluide*. Probably it is caused by great diminution in the tension of the pulmonary artery, so that when the ventricles contract a twist or constriction is developed at its root, and the blood passes through the twisted orifice into the part beyond which is relatively dilated—hence the occurrence of murmur. One of the commonest conditions associated with the murmur is a feeble character of the respiratory movements. From the general weakness or lassitude attendant upon an exhausting illness, such as acute articular rheumatism, respiration is of a feeble or superficial character, and the lungs are imperfectly expanded. The quantity of air ordinarily inspired being merely sufficient to overcome their elasticity, the blood passes with an unusual degree of facility through the capillaries of the pulmonary artery; the tension of the latter is greatly lowered, probably its trunk is shortened, so that during the systole of the ventricles a condition favourable to the development of a twist at the origin of the vessel is established. The full expansion of the air-vesicles during forcible inspiration restores the normal tension of the artery, and the tendency to the production of a twist at its root is obviated. In other words, the condition of the artery during feeble respiratory efforts is one of defective tone—if the term can be applied to a vessel which contains little or no traces of muscularity—the defect being due to diminished capillary resistance. A point which may be mentioned as favourable to the view just expressed is that during forcible inspiration in the normal state the pulmonary second sound becomes markedly accentuated. Furthermore, the subsidence of the murmur in the vertical position may fairly be attributed to the effect of

gravity—the weight of the heart exercising a traction influence which helps to maintain the calibre of the arteries springing from it unaltered.*

In some cases it is conceivable that extreme pressure on the diaphragm from below may cause the murmur in two ways—by dislocation of the heart upwards, which relaxes or shortens the trunk of the pulmonary artery, and by impeding the normal extent of the respiratory movements.

It may be observed that, in cases of diminished or superficial breathing, the support afforded by the imperfectly expanded lungs against the walls of the pulmonary artery being lessened, a condition favourable to the development of a twist or constriction at its root during ventricular systole is established.

Dynamic Murmurs.— Dynamic murmurs are, as it has already been observed, developed only at the auriculo-ventricular orifices, and they indicate regurgitation of blood from the ventricles backwards into the auricles. There are no sufficient

* Dr. Russell (Investigations into some morbid Cardiac Conditions: W. Russell, M.D., 1886) offers an ingenious explanation of the mode of production of pulmonary systolic murmur, which is worthy of consideration. He points out that in debility there is an atonic dilatation of the cardiac cavities and an increase in the residual blood in its various chambers. As the pulmonary artery arches over the left auricle, any increase in the size of the left auricle, or any abnormal fulness of it, interferes with the normal play of the vessel. This is understood when the fixed position of the pulmonary artery, as it passes to the root of the lung, is taken into consideration. If anything tends to increase the distance which the pulmonary artery has to travel, the part which is in relation to the root of the lung does not change its position, but remains fixed; so that any change produced must take place by the movement of the origin of the vessel. When the left auricle and left ventricle become over-distended with blood, the conus arteriosus, in its normal descent during ventricular contraction, carrys with it the root of the pulmonary artery, but produces a flattening of the vessel by a greater or less approximation of its opposite surfaces, just as a piece of elastic tubing becomes flattened when stretched over anything placed behind it. The murmur thus becomes a measure of the degree of distension or dilatation of the left heart.

grounds to establish the view that these murmurs could be developed by irregular vibrations of the valves.

The first dynamic murmur which will be considered is that heard best over the mitral area—

FUNCTIONAL MITRAL MURMUR.

The occurence of mitral and tricuspid systolic murmurs from relative incompetency has been already referred to. Though these murmurs are, no doubt, dynamic in their mechanism, still they are associated with such grave conditions of disease that they can hardly be placed amongst those murmurs, hæmic or dynamic, which are not associated with structural change, and which are of a transient nature, and comparatively trivial in importance. The mechanism of production of a regurgitant auriculo-ventricular murmur, whether it arises from the degeneration of an hypertrophied and dilated ventricle, or is met with in chorea and chlorosis, is probably the same. One distinction, however, may be drawn between the murmurs which are about to be considered and those which have been already referred to—viz., murmurs which are dynamic in their mechanism, and which are not produced by overstrain of the ventricular walls, depend upon a condition of relaxation of the fibres of the ventricular wall, brought about by disordered nutrition, owing to an impoverished state of the blood.

The conditions in which a functional mitral murmur is met with may be tabulated as follows:—

1. Chlorosis and anæmia.

2. In adynamic conditions of the system, which probably lead to defective innervation of the heart, as in acute rheumatism, in low forms of fever, especially typhus, where the first sound is replaced by a soft systolic apex murmur (Stokes).

It may also be found in cases of cerebral disease—basilar meningitis, cerebral tumour, &c.

3. In neurosis of the heart, which produce an irregular action of it, as chorea, or heart affections which follow the excessive use of tea and tobacco.

4. In irritable conditions of heart, attended with palpitation, following fatigue from over-exertion (Da Costa), or traceable to nervous debility, excessive sexual excitement, purpura, &c.

There are some points which help in the differential diagnosis of functional from organic mitral murmur, which may be tabulated thus:—

1. The functional murmur is more inconstant and more variable in intensity than organic murmur.

2. It is rarely a substitutive murmur; a left ventricular first sound is generally audible, and the murmur can be recognised as following the systolic sound, so that its rhythm is, strictly speaking, *post-systolic*.

3. It is heard loudest at a point slightly above the apex beat, over the body of the ventricle (Da Costa).

4. Usually present in the recumbent posture, it generally ceases when the patient sits up. If feebly audible in the erect position, it often can be made to disappear by active exercise.

5. It is unattended with accentuation or reduplication of the pulmonary second sound, or any signs of pulmonary distress.

6. There is no alteration in the size of the heart or in the position of the apex beat.

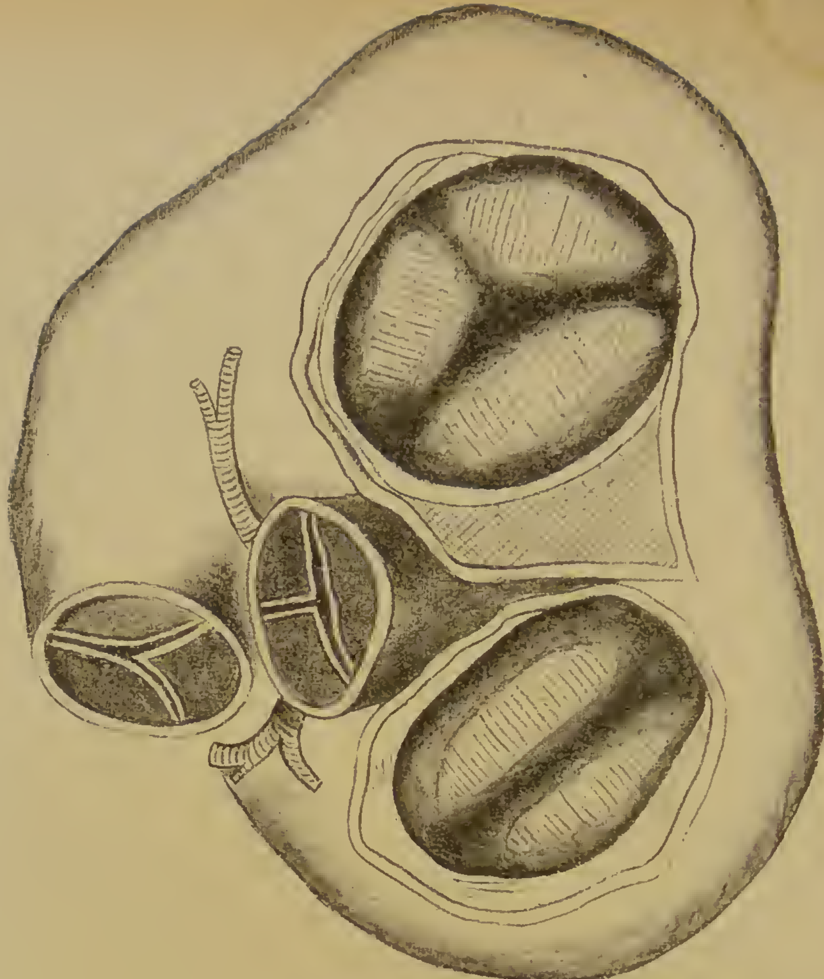
It is difficult to assign the exact mode of production of functional mitral murmur. Hayden* maintained that its

* Hayden, Diseases of the Heart and of the Aorta. P. 282.

mechanism was due to atony or partial yielding of the walls of the left ventricle at the acme of systole. "A yielding of a particular portion of the walls of the ventricle during the centripetal movement, which takes place in the act of contraction, may so alter the direction in which one or both of the *musculi papillares* acts upon the segments of the mitral valve as totally to invert their function, by rendering them effective agents, not in closing but in opening the orifice of communication with the auricle. Such yielding may be due either to a want of sufficient contractile power in a particular part of the walls of the ventricle, or to atony or want of co-ordination in the contraction of the different portions of those walls."

Another view of the mechanism of the murmur of much interest is expressed by Dr. Byrom Bramwell. Dr. Bramwell points out that the mitral orifice is surrounded in its posterior two-thirds by the muscular fibres of the ventricle, whilst the anterior third, which is fibrous, is formed by the fibrous continuation of the two posterior aortic sinuses to which the great anterior flap of the mitral valve is attached. The occurrence of mitral incompetency is explained very simply by a want of tone in the muscular fibres of the left ventricle and of the muscular fibres which surround the mitral orifice—the muscular sphincter, as it is termed by Dr. Bramwell. His explanation would appear to be based upon the experiments of Ludwig and Hasse at Leipzig, made in 1880, showing that the size of the auriculo-ventricular orifices are fully one-half smaller in systole than in diastole, as is shown in Plate. It appears, further, to have been suggested by an interesting *resumé* of Hasse's and Ludwig's observations in a lecture delivered at Cambridge by Dr. Donald MacAlister upon "the Form and Mechanism of the Heart;" but a careful perusal of this lecture scarcely affords grounds for the descrip-

tion of the mitral orifice given by Dr. Bramwell. As described by Henle, the left auriculo-ventricular zone is a half ring composed of strong fibrous tissue interposed between the auricle and the ventricle, the ring being completed by the continuity of the anterior flap of the mitral valve with the two posterior aortic valves. This ring forms a perfect line of demarcation between the auricle above and the ventricle below. It has attached to it above the fibres of the auricle, whilst below the fibres of the ventricle are connected with it in the following manner:—The external longitudinal fibres arise from it; pass then downwards until they reach the whorl or vortex at the apex, where some of the fibres pass inwards to form the papillary muscles; the remaining fibres spread out into an inner layer of muscular fasciculi, which are continued up to the fibrous rings at the base of the heart. An important point to note in connection with these fibres is that they arise from the fibrous rings, pass over the external surface of the heart, and return again to the fibrous rings, internally, either directly or through the intervention of the chordæ tendineæ and valve flaps. Between this external and internal layer of muscular fibres intervenes a set of fibres, the middle layer, which are also attached to the rings at the base, and which pass downwards with increasing degrees of obliquity, until, at a certain distance from the apex, the fibres can be said to pass transversely, and here, no doubt, they assume the form of a sphincter muscle (see Plate). But this arrangement of fibres does not take place in the supra-papillary region of the ventricle. It would perhaps be a disadvantage to have a sphincter muscle above the termination of the papillary muscles, and forming part of the auriculo-ventricular zone. It would be likely, during its contraction, to interfere with the integrity and smoothness of the aortic ring; and further, there is no



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occasion for its existence here, as the small volume of blood which is left in the ventricle after its contraction, and which fills the supra-papillary space (the aortic vestibule of Sharpey), has an important use assigned to it. The change in shape of the auriculo-ventricular rings during systole is obviously due to the combined action of the longitudinal and oblique fibres which are attached to it, and it remains to be proved whether an atonic condition of those fibres, by not sufficiently narrowing the ring, can lead to incompetency of the valve.

FUNCTIONAL TRICUSPID MURMUR.

Dynamic tricuspid murmur occurs in similar conditions of hypertrophy and dilatation of the right ventricle to those which on the left side of the heart produce mitral regurgitation—viz., relative incompetency of the auriculo-ventricular valve. Tricuspid murmur is, however, heard much more rarely in relative incompetency than mitral murmur, owing to the comparatively feeble contraction of the right ventricle.

A point of considerable interest in connection with tricuspid systolic murmur lies in the view which has been urged by M. Parrot,* viz., that all anæmic murmurs are developed at the tricuspid orifice and indicate tricuspid regurgitation. He placed the site of maximal intensity of the murmur in the fourth left interspace, though it was sometimes heard best in the third or fifth interspace; it was transmitted upwards and to the right in the direction of the right sterno-clavicular articulation. The murmur was not audible to the left of the nipple, and was accompanied by double pulsation in the jugular veins. The murmur was produced by dilatation of the right ventricle, and, therefore, of the auriculo-ventricular orifice, which led to incompetency of the valve closing it; and

* See *ante*. Arch. Générales de Médecine, 1866.

this enlargement of the ventricle was due to relaxation of the muscle, brought about by impoverishment of the blood. This murmur was heard not alone in anæmia, but in certain nervous and febrile conditions.

Dr. Russell,* who adopts Parrot's view as to the existence of tricuspid murmur in anæmia, directs special attention to the indications of enlargement of the right ventricle, and he is disposed to raise objections, not, however, of a captious nature, to the routine formula laid down in most works on cardiac diseases as to the signs of enlargement of the right ventricle—viz., pulsation at the lower part of the sternum and in the epigastrium. He points out that this is positive evidence of enlargement in a high degree, but that a lesser degree of enlargement is indicated by pulsation, which appears to the left of the sternum in the third, fourth, and fifth intercostal spaces. When pulsation is observed in the second intercostal space, it is due in part to the pulmonary artery, in part to the conus arteriosus.

The view put forward by Dr. Russell with regard to the murmur in anæmia and chlorosis is that in those cases a systolic murmur is first heard over the pulmonary artery, often accompanied by pulsation in the second left interspace, and followed by an accentuated pulmonary second sound. This murmur is accounted for by the relaxed condition of the heart, which, in anæmia, allows the walls of its chambers to yield to the strain thrown upon them. The left auricle is over-distended with blood, and it produces that amount of stretching and flattening of the pulmonary artery which is necessary for the production of murmur (see foot-note, p. 185). After a time, the systolic murmur is heard in the third and fourth left spaces; it is attended with pulsation in

* *Opus cit.*

the jugular veins, and the murmur ultimately replaces the pulmonary murmur, which becomes gradually less and less distinct. The murmur so developed is one of tricuspid regurgitation. It gradually extends its area of audition until it is heard as high as the second left space, over the middle and lower two-thirds of the sternum, and also to the right of the sternum in the second right space (aortic area). *Post-mortem* examinations showed that in certain cases the second right interspace was occupied by the right auricular appendix, which here covered the aorta, so that the position of the auricle would be specially favourable for the transmission to the aortic area of a murmur of tricuspid regurgitation. In a later stage of tricuspid regurgitation the murmur is heard over the situation of the conus arteriosus, slightly to the left of the position of the root of the pulmonary artery. This is due to altered position of the heart in its relation to the chest wall. As the right side enlarges, the pulmonary artery is thrust upwards to the left; and the right heart, as a whole, undergoes a kind of rotatory movement, which brings more and more of its surface in contact with the chest wall, the process of rotation from left to right taking place until epigastric pulsation makes its appearance. The displacement upwards and outwards of the pulmonary artery would account for the gradual subsidence of pulmonary murmur when tricuspid regurgitation had been fully established (Russell). The ultimate condition of the heart in anæmia is reached when, in addition to tricuspid regurgitation, functional regurgitation is established at the mitral orifice and is indicated by a systolic apex murmur.

There is, however, authority of considerable weight against the view that the pathognomonic murmur of anæmia is one of tricuspid regurgitation. Dr. Balfour is a strenuous sup-

porter of the view that anæmic or chlorotic cardiac murmur is a systolic mitral murmur, which is first heard in the second left space, being conveyed there by a dilated left auricular appendix. Following this is the ordinary murmur of mitral regurgitation, then a distinct tricuspid murmur with more or less undulation in the jugular veins, and lastly a systolic aortic murmur, which, according to Dr. Balfour, is propagated into the carotid arteries.

It would be difficult, if not impossible, to harmonise these discrepant views. Possibly, the difference in subjective receptivity of a variety of observers with regard to sounds heard upon auscultation may, in a measure, account for divergent opinions.

Perhaps the position with regard to cardiac murmurs in anæmia and chlorosis may be summed up as follows:—

1. The first, most constant, and, it may be, the only murmur to be heard in anæmia or chlorosis, is a systolic murmur, developed in the pulmonary artery.

2. Frequently associated with this murmur, and occasionally replacing it, is a systolic murmur heard best over the tricuspid area, sometimes transmitted to the second right interspace so as to simulate an aortic murmur.

3. Following usually this murmur is one of functional mitral regurgitation. The functional mitral murmur is, however, frequently absent, or it may be present *alone* in cases where defective innervation and atony of the muscular wall of the left ventricle exist without there being evidence of an anæmic condition (see p. 187).

4. Last, a murmur having its maximal seat of intensity over the aortic area may be developed, so that murmurs may exist over all the orifices of the heart.

5. The murmurs regarded as aortic in seat are for the most

part generated at the tricuspid orifice, while those described as existing in the carotid are almost invariably produced by pressure with the stethoscope.

6. The cardiac murmur (or murmurs) is usually associated with murmurs in the veins of the neck.

7. Anæmic or chlorotic murmurs are of a transient kind, disappearing as the general health improves.

PERICARDIAL MURMURS.

In the normal condition the two surfaces of the pericardium glide upon each other during the movements of the heart without the production of any sound, but when they are roughened by an inflammatory exudation, the friction of one against the other produces rubbing or grating sounds, which are called pericardial friction murmurs. These murmurs accompany the movements of the heart, hence they received the designation of the *to-and-fro rubbing sound* (Watson); from their resemblance to the creaking of new leather the sound was first described by Collin under the name of a *bruit de cuir neuf.*

Friction sounds are sometimes accompanied by a fremitus, commencing with the movements of the heart, similar in character to that observed by palpation in pleurisy.

The intensity of the friction murmurs depends mainly upon three conditions—viz., the degree of energy with which the heart contracts, the amount, thickness, and locality of the fibrinous exudation, and the position of the patient. By altering the attitude of the patient so that the visceral and parietal layers of the serous membrane are either brought into close contact or partially separated from each other, the friction-murmurs are made to appear or disappear Thus they may be weakened or abolished when the patient is

placed in the prone position; and, on the other hand, they may be called into existence or intensified by getting him to sit or stand up, or to lie on his left side.

The friction murmurs usually make their appearance first at the base of the heart, owing probably to the very close proximity of the two layers of the pericardium to each other and the nature of the basic impulse. They are absent or inconstant during the stage of effusion, returning as absorption takes place, and ceasing when adhesion of the opposing serous surfaces takes place.

The cessation of friction in adhesion commonly takes place from above downwards, the last part from which it disappears being over the apex of the heart. This is explained by Hayden as due to the very mobile condition of the extremity of the ventricular mass of the heart.

Occasionally friction sounds present varieties over different areas of the cardiac region. These are due to localisation or concentration of the exudation upon different parts of the heart.

Friction murmurs are sometimes developed from exudation on the outer surface of the pericardium (indurated mediastino-pericarditis). They are indistinguishable acoustically from intra-pericardial friction sounds. It is in such cases that the paradoxical pulse is met with.

An extra-pericardial sound is occasionally produced by the movements of the heart and pericardium against the pleura (especially the left), the surfaces of which have been roughened by inflammatory exudation. This sound has been already referred to (p. 97).

Waterwheel Sound.—Occasionally a sound like the noise made by the floats of a water-wheel (*bruit de moulin*) may be heard in conditions of effusion of liquid and air near to the

heart. Where large thin-walled pulmonary excavations are situated in those parts of the lungs which adjoin the heart, the air may be expelled from the cavities during systole with a blowing or sipping sound. The sound heard in such cases may vary much in character, being amphoric or metallic in timbre, or resembling a bubbling or gurgling râle. All these sounds depend on the movements of the heart, and are independent of the movements of respiration.

ENDOCARDIAL AND EXOCARDIAL MURMURS.

It is now convenient to tabulate the distinctive features of endocardial and exocardial murmurs.

Endocardial murmurs present usually the following characters:—

1. They are soft and blowing in sound, and occasionally present a musical tone.

2. They are associated with the sounds of the heart.

3. They are heard best at different fixed sites over the cardiac region, and are propagated in fixed directions by the current of the blood.

4. They are usually single. A double murmur is, however, frequently met with over the aorta, less commonly over the mitral area.

5. They are, with few exceptions, loudest when the heart beats forcibly, as after vigorous muscular exertion. Cases where murmurs disappear after exertion are those which are associated with an atonic condition of the heart's muscle.

6. They are not influenced by pressure. Exceptionally, pressure over the pulmonary area in young persons may generate a systolic murmur.

7. They are influenced to some extent by respiration; a systolic apex murmur may be louder during inspiration than

during expiration; and a systolic tricuspid murmur may be inaudible at the beginning of expiration. Functional pulmonary murmur is usually rendered inaudible at the acme of forcible inspiration.

8. Some murmurs are inaudible, or become weakened when the patient sits up or stands. This is specially the case with mitral functional murmur.

9. They may be accompanied by *frémissement cataire.*

Exocardial or pericardial sounds have the following diagnostic characters:—

1. They are grating, rubbing, or scraping in quality.

2. They are associated with the movements—not the sounds—of the heart.

3. They are usually limited in extent, being heard only over the seat of production, and not propagated to a distance by the blood-current. They may be heard over the entire or any part of the cardiac region, and may shift their place from day to day.

4. They are generally double, though at the commencement of pericarditis a single rough murmur, diastolic in rhythm, may be occasionally heard over the base of the pulmonary artery or conus arteriosus. The sounds of the heart are usually intermingled with the murmurs.

5. They are, as a rule, intensified or brought into existence by forcible inspiration.

6. They may be increased by pressure over the præcordia, though occasionally an increase of pressure decreases the loudness of the murmurs.

7. They have a distinctly *superficial* character.

8. They are modified by position: their place of greatest intensity being made to vary.

9. They may be accompanied by a sensation of friction communicated to the hand.

AUSCULTATION OF THE ARTERIES AND VEINS.

On listening with the stethoscope over the carotid or subclavian arteries two sounds are heard in the normal state. The first coincides with the expansion of the vessel, and is partly due to this expansion as well as to transmission of the first aortic sound. The second sound is altogether a transmitted sound from the closure of the aortic valves. The first sound may be heard over the aorta, both thoracic and abdominal, and when the heart's action is vigorous it is distinctly appreciable close by the vertebral column. The second sound is not usually heard beyond the carotid and subclavian arteries.

In disease a first sound may be produced in the peripheral arteries if they are more forcibly distended than normally, and if they are brought more quickly than usual to a condition of maximal tension.

These conditions serve to explain the occurrence of a very marked systolic sound in the femoral arteries in cases of aortic regurgitation. Traube points out that a second sound, like that of the heart, may be heard in the femoral vessels if the regurgitation into the left ventricle be very large in amount. He accounts for the sound by the rapid transition of the artery from a state of extreme tension to one that is very low; just as a tense membrane, or cord like a violin string, emits a sound when suddenly relaxed, so also a sound is produced under an analogous condition of the arterial walls. Bamberger, who specially studied this phenomenon, points out that it is only in the femoral arteries, owing to their long and direct course, that a double sound is ever heard, and that these vessels are specially adapted for the reception and transmission of a regurgitant wave of blood; when the volume and force of the regurgitant wave are above the average, the result of the

increased tension in the artery is a sound; when the wave is small and the arterial tension low, a murmur is produced. Most practical physicians are, however, disposed to doubt the occurrence of a second femoral sound in aortic patency, whilst the diastolic murmur heard in such cases in the peripheral arteries is, generally speaking, artificially produced.

The first arterial sound may be replaced by a murmur which occurs spontaneously in disease, or is due to the pressure of the stethoscope.

In health compression of the large arteries with the stethoscope gives rise to a murmur soft and systolic in character. In cases where the heart is hypertrophied, or where the blood is abnormal in its composition, the compression murmur is harsh and whizzing.

In aneurysms of the great vessels a systolic murmur is frequently heard from the development of fluid veins at the mouth of the sac. It is a remarkable fact, however, that the existence of a murmur is exceptional in thoracic aneurysm, whilst an aneurysm of the abdominal aorta is often attended with a murmur, heard when the patient is in the horizontal position, but inaudible when he sits up. The increased tension of the sac, due to altered position, prevents the formation of fluid veins—hence absence of murmur (Corrigan.)

A systolic murmur in the subclavian artery is met with in certain conditions. It occurs independently of murmur in the carotids, and may be classified under two heads—(1) cases of subclavian murmur occurring in mechanics, such as blacksmiths, carpenters, sawyers, &c., where the nature of the occupation engenders a disproportionate degree of development of the subclavian muscle; (2) cases of chronic pneumonic infiltration of the lung.

Subclavian murmur, when found in mechanics, is usually

observed on both sides, and is always intensified by getting the subject under examination to hold out the arm horizontally. It may be audible only in this position.

Subclavian murmur, in solidification of the apex of the lung, is usually met with on the left side, and is heard best during the acme of inspiration, and especially when inspiration and the systole of the heart coincide. This serves to explain the want of constancy and variability in intensity of the murmur. The sign is often of value in the diagnosis of pulmonary phthisis.

A systolic murmur developed in the arteries of the base of the brain, and present in children both in health and disease, has been described by Fisher. It is a soft blowing murmur heard best over the great fontanelle and its immediate neighbourhood, usually from the fourth month to the second year of life; but where, from disease, the fontanelles remain open, as late even as the sixth year of life. The murmur is believed to arise in the tortuous arteries of the cranial base, and to be transmitted thence through the brain mass to the surface. It is termed the *encephalic murmur*. The existence of this murmur cannot be said to have any diagnostic significance.

Diastolic murmur existing in the arteries has been observed in cases of aortic regurgitation. It has been already referred to as due to the reflux of blood along the artery occurring during the ventricular diastole. This murmur has been made the object of special study by Duroziez, who regards it as almost pathognomonic of aortic patency, though it has been met with in endarteritis of the aorta and large trunks, in aneurysm of the aorta, in hypertrophy of the left ventricle from cirrhotic kidneys, &c. (Friedreich). Duroziez points out that in aortic regurgitation, by making pressure with the stethoscope upon peripheral arteries like the subclavians or femorals, a double

murmur (*bruit de scie*), systolic and diastolic, can be heard, the first being due to the systolic blood wave, and the second to the passage of the backward wave from the periphery through the artificially contracted vessel. The facility with which the diastolic murmur can be produced may be taken as a measure of the amount of aortic regurgitation.

VENOUS MURMURS.

Venous murmurs are heard almost exclusively in the internal jugular vein, though when loud they may be heard in the intra-thoracic veins (venæ innominatæ and superior cava). A continuous venous hum can be heard in many healthy persons by listening with the stethoscope, pressed into the interval between the sternal and clavicular orifices of the sterno-cleido-mastoid muscle, the point of selection in the examination of jugular murmur. This murmur is likened, acoustically, to the noise made by the wind in a chimney, or in passing through a crevice, or to the noise made by a French humming-top, from which it is designated the humming-top murmur—the *bruit de diable*—in German, *Nonnengeräusch.*

The cause of this murmur appears to be a whirling or vortiginous movement, which is developed in the blood as it passes from the jugular vein into a relatively larger portion of this vessel, the bulb, which corresponds with its junction with the innominate vein, so that a condition favourable to the formation of fluid veins exists, and hence the development of murmur. The great veins within the thorax are surrounded by processes of the deep cervical fascia, so that they cannot shrink so as to accommodate their capacity to a diminution in the bulk of the blood, as do the veins generally; therefore, being relatively dilated, they afford the conditions for the development of sonorous fluid veins. This state of unvarying

capacity of the intra-thoracic venous trunks is termed by French authors *canalisation.* This theory explains the intensification of *bruit de diable* by turning the head well to the side opposite to that auscultated. On rotation of the head the cervical fascia and muscles, especially the omohyoid, are put upon the stretch, the jugular vein is compressed and narrowed, so that the normal physiological difference in the calibre of vein and of its bulb is increased, and so the conditions favourable to the development of fluid veins are intensified. This accounts for the development of the murmur whilst the head is rotated, though it may be absent when the head is held straight.

Although the venous hum may frequently be heard in persons in health, it is by far more intense in chlorosis, and its production in this disease is less dependent on altered position of the head. Of so marked a character is the *bruit de diable* in chlorosis that it is regarded as the sign, *par excellence*, of the circulatory disturbances existing in this affection.

It is in chlorosis that an opportunity is afforded for the special study of the characters of the venous murmur. Besides its intensification by altered position of the head, the murmur is frequently accompanied by *frémissement*, and, though more or less continuous, is found to be rhythmically increased in loudness during inspiration and auricular diastole, and by whatever influences the acceleration of the outflow through the jugular veins. In deep inspiration the efflux of blood from the jugular vein is favoured ; in expiration it is retarded. During a suspension of respiration the increased pressure on the intra-thoracic venous trunks causes a greatly diminished flow through the jugulars, and the murmur may become so feeble as to be scarcely audible. During the auricular diastole, immediately after the ventricular systole, a

certain amount of aspiratory force is produced which favours the flow of venous blood, so that at this period *bruit de diable* is intensified. The flow of blood through the veins is also accelerated by position, hence the murmur is best heard when the patient sits up; it may be inaudible in the recumbent posture.

A murmur in the right jugular vein is much louder than in the left—(1) because the bulb of the right jugular vein is larger than the left *bulbus*; (2) the blood flows *directly* on the right side from the jugular vein into the right vena innominata; on the left the jugular joins with the left vena innominata at an appreciable angle; (3) the flow of blood through the right innominate vein is favoured by its passing in a direct line into the superior cava, whilst the left innominate vein has to cross from left to right to open into the cava at an obtuse angle. For these reasons the louder venous murmur can be heard often on the right side as far down as the level of the first rib in the region of the right innominate vein, whilst it is absent in the symmetrical position on the opposite side.

The murmur on both sides, though intensified by moderate pressure of the stethoscope, may be completely obliterated if the pressure be greatly increased, so that by alterations of pressure the murmur may be made intense or feebly pronounced, as the observer pleases. The murmur may be completely arrested by pressing firmly upon the dilated lower end of the jugular vein, so as to close it; it is at once reproduced when the pressure is removed.

Intermittent Venous Murmur.—This variety of murmur is characterised by an absence of the continuous character which is observed in *bruit de diable.* It has the same blowing character as the latter, but is much feebler. Three varieties

of intermittent venous murmur have been described—presystolic, double, and diastolic.

Presystolic venous murmur is heard, according to Parrot, in all persons when lying down, from the passage of the blood backwards through the mouth of the internal jugular vein during the auricular systole. This is certainly *not* a constant phenomenon.

Double venous murmur has been observed at the root of the neck in cases of tricuspid regurgitation, presystolic and systolic in rhythm (Parrot). It is developed by the contraction of the right auricle, and by the regurgitating wave of blood which is sent into the veins during the contraction of the right ventricle. It is probable that most of such cases present a rhythmical intensification and enfeeblement of a continuous venous hum—intensified during inspiration and cardiac diastole; weakened, or entirely absent, during expiration. A double venous pulsation, appreciable by inspection, and sometimes by palpation, no doubt, exists in tricuspid regurgitation, but a distinctly marked double murmur in the veins in such cases must be of rare occurrence.

Diastolic venous murmur has been observed by Friedreich where there has been increased pressure of the aorta on the vena cava, or venæ innominatæ. The cases in which its occurrence has been noted are hypertrophy of the left ventricle, with strong aortic pulsation and exophthalmic goître.

Before passing from conditions affecting the circulation through the jugular veins, it may be well to allude to the sound described by Bamberger, which is developed in the bulb of the jugular vein in cases of tricuspid insufficiency. It has been pointed out that venous pulsation of the veins in the neck does not occur unless the valves at the root of those veins are incompetent. In the early stage of tricuspid regurgitation,

whilst the valves are unimpaired, a pulse is developed in the bulb of the jugular veins which gives rise to a sound produced by the forcible vibrations of the valves. This sound is termed *the sound of the jugular valves*, and it is of diagnostic value in those cases of tricuspid insufficiency of an intermittent character, and where the condition is in an early stage of development, and unaccompanied by pulsation of the veins in the neck.

FEMORAL VENOUS MURMUR.

A murmur, systolic, presystolic, and diastolic in rhythm, has been observed occasionally in the femoral veins; its common cause is tricuspid regurgitation.

A murmur, accompanied by thrill, has been met with in the femoral vein, occurring during forcible expiration, and the sign is regarded as indicative of an incompetent condition of the valves situated at the cardiac end of the vein—a condition considered to be a common cause of varix. The murmur or thrill is detected by everting the thigh, and placing the finger or the stethoscope lightly over the vein just below Poupart's ligament. Each time the patient coughs a marked thrill and a murmur will be perceived.

CHAPTER X.

PHYSICAL EXAMINATION OF THE ABDOMEN.

The physical examination of the abdomen will be first considered in a general manner, and, subsequently, the methods of examination of the principal organs contained within it will be dealt with. This order, though likely to give rise to repetition, presents counterbalancing advantages.

The methods employed in the investigation of disease within the abdomen are like those adopted in the investigation of affections of the chest, viz.—

1. Inspection.
2. Palpation.
3. Percussion.
4. Auscultation.
5. Mensuration.

Before taking up these methods in order, it is well to refer to the division which has been made of the surface of the abdomen into certain regions.

Regions of the Abdomen.—The regional divisions are usually made by the following lines:—

The first line is drawn transversely at the level of the most prominent point of the lower costal cartilages or ninth ribs on either side. The second line, drawn parallel to this, connects the highest points of the crests of the ilia.

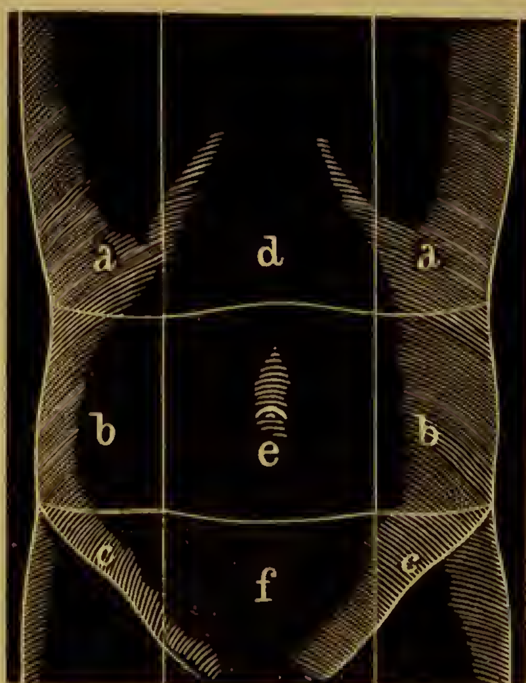
Two vertical lines cross the transverse lines at right angles; they are drawn upwards from the centre of Poupart's ligament. We have thus an upper, middle, and lower zone, each divided into three parts.

Upper zone contains the right and left hypochondria and the epigastrium.

Middle zone contains the right and left lumbar regions, with the umbilical region intervening.

Lower zone, the right and left iliac regions, with the hypogastrium between.

Fig. 35.



REGIONS OF THE ABDOMEN.

(*a.*) Hypochondriac regions.
(*b.*) Lumbar regions.
(*c.*) Iliac regions.
(*d.*) Epigastric region.
(*c.*) Umbilical region.
(*f.*) Hypogastric region.

(Taken from DR. GRAHAM BROWNE'S "Medical Diagnosis.")

In the epigastric region are situated superficially the body and pyloric end of the stomach and the left lobe of the liver; deeply the pancreas, hepatic vessels, cœliac axis, and part of the aorta.

In the right hypochondrium are the right lobe of the liver and the gall bladder.

In the left hypochondrium are the cardiac end of the stomach and the spleen.

In the umbilical region are the transverse colon, part of the mesentery, omentum, and small intestine.

In the right lumbar region are the ascending colon and right kidney.

In the left lumbar region are the descending colon and the left kidney.

In the hypogastric region are the small intestine, and occasionally the distended bladder.

In the left iliac region is the sigmoid flexure of the colon.

In the right iliac region is the cæcum.

I. INSPECTION.

When inspecting a case of abdominal disease the position assumed by the patient should be carefully noted. He may lie in an indifferent position; the decubitus may be supine with the legs drawn up, as in peritonitis; prone, with the hands pressed against the belly, as in lead colic; or lateral, with the thighs flexed and the body bent, as in renal and hepatic colic.

Next, alterations in the shape, general size, prominence, or retraction, should be noticed.

The shape or form of the abdomen varies in health within considerable limits. In those who are accustomed to eat and drink in excess, or who, through heredity or other causes, have a tendency to obesity, the abdomen becomes remarkably prominent, and often pendulous. In old age, it often becomes small and shrunken, with an undue prominence of its bony walls.

The most prominent variations occurring pathologically are those involving—(1) enlargement, or (2) retraction.

(1.) *Enlargement.*—The most common change met with in the abdominal cavity is enlargement, general or partial.

General Enlargement, apart from an undue development of fat in the abdominal walls and in the mesentery, is caused—(*a*) by effusion of fluid into the peritoneal sac (ascites); (*b*) by the accumulation of gas in the intestines; and (*c*) by ovarian tumours of large size.

Partial Enlargement is due to increase in size of the different abdominal organs—the liver, stomach, spleen, uterus, ovaries, &c., or by tumours of various kinds connected with these organs, or other structures in the abdomen. Thus bulging in the right hypochondrium may be due to enlargement of the liver; in the left hypochondrium, to that of the spleen; in the epigastrium and umbilical region, to dilatation of, or tumours connected with, the stomach; in the iliac or inguinal regions, to enlargement of the ovary; in the hypogastric regions, to enlargements affecting the bladder or uterus, &c., &c.

The shape of the abdomen in general enlargement varies. In ascites, if the fluid effused be large in amount, the abdomen sags out at the sides as the patient lies upon his back, the anterior part of the abdomen being flattened; whilst, if the erect position be assumed, the prominence is greatest towards the hypogastric region. In meteorism the abdomen is spherical in form, protuberant in front, and unaltered by position. The same characters are observed in certain forms of ovarian tumours of large dimensions, though, *as a rule*, ovarian tumour is movable and gravitates towards the depending position of the abdomen, rendering the integument tense over an area corresponding to the position of the tumour.

The appearance of the abdominal wall in extensive ascites

is peculiar. The skin often assumes a shining, anæmic, and bluish-white appearance. The superficial veins are enlarged, coursing over its surface, as blue coloured plexuses, and giving to it a marbled appearance. The turgescence occurs in the internal mammary and the epigastric veins, and is an indication of the establishment of a collateral circulation in obstruction through the portal vein, or involving the inferior vena cava. In such cases the widely-dilated veins cause a marked prominence around the umbilicus, which is known as the *Caput Medusæ.* Where the distension of the integument is so great as to cause a separation of the tissue elements of the corium, whitish lines are observed crossing the surface, like those which occur in pregnancy.

(2.) *Retraction.*—Retraction of the abdomen, or diminution in its volume, usually affects the entire abdominal cavity. It is observed as a sign of general emaciation and inanition. Where extreme in character, the outline of the vertebral column, with the pulsations of the aorta lying upon it, may be seen.

In basilar meningitis a boat-shaped depression of the surface of the abdomen is generally observed. The contraction is caused by irritation of the nerve centres which preside over the movements of the muscular coat of the intestines.

II. PALPATION.

For the purpose of thoroughly palpating the abdomen and its contents, the patient should be placed in the recumbent position with the knees raised and the shoulders slightly elevated by a pillow. This position serves to relax the abdominal muscles, a condition which may be further attained by drawing the patient's attention away from the process of examination, and by getting him to breathe deeply. It is

suggested that where there is a difficulty in getting the patient to keep his diaphragm fixed, he should be made to count "one," "two," "three," &c., up to as high a number as possible without drawing breath; during this time deep palpation may be advantageously employed. In palpating the abdomen, the hand should be previously warmed, and then applied evenly and gently to the surface with a kind of kneading motion, the fingers being depressed as different regions are examined. Whilst palpating it is often of importance to get the patient to change his position—first to one side, then to the other; this method is specially useful in the examination of tumours.

The special points which are observed by palpation relate to—(*a*) the condition of the abdominal wall; (*b*) the size, form, and mobility of the abdominal organs; (*c*) the causes of general tumefaction of the abdomen, such as ascites, meteorism, or the existence of inflammatory effusion or tumours of various kinds.

(*a*) The condition of the abdominal wall involves an examination of its temperature, presence or absence of œdematous or emphysematous swelling, increased sensitiveness (hyperæsthesia) to pressure, and contraction of its muscles. Contraction of the "recti" muscles constitutes one of the great difficulties to palpation; frequently a contraction of one of its intersections may simulate a tumour involving the stomach or springing from the left lobe of the liver. It sometimes happens that a matter of doubt arises as to whether a tumour is situated within the rectus muscle, or in the abdomen beneath it. By keeping the hand over the tumour, and getting the patient to raise himself towards the sitting position, the point may be determined.

(*b*) The size, form, and mobility of the abdominal organs will be discussed in the sections referrible to each.

(c) *The causes of general tumefaction of the Abdomen.*—These will be here specially considered in relation to diseases of the peritoneum, and accumulations of fluid in the peritoneal sac.

In peritonitis, if general, great pain and tenderness upon pressure exist over the entire surface of the abdomen—even the lightest touch may give rise to acute suffering. In circumscribed peritonitis the pain and tenderness are confined to the area engaged.

Cancerous or tuberculous degenerations of the peritoneum reveal themselves by the presence of irregular nodular masses which, especially in cancer, can be felt through the abdominal parietes. Large masses, representing colloid degeneration, may, usually without difficulty, be felt over different regions of the abdomen.

Accumulations of fluid in the peritoneal sac are usually of a serous character (ascites); rarely they consist of inflammatory exudation. The presence of fluid gives rise to a sensation of *fluctuation.*

Fluctuation.—The ordinary way in which fluctuation is obtained is by getting the patient to lie upon his back, or to stand erect, and then to place one hand flat upon one side of the abdomen and to tap the other side with a finger of the other hand—a distinct wave or undulatory sensation is felt. The wave may usually be seen to pass over the surface.

If the amount of fluid in the peritoneal sac be small, fluctuation may be elicited only by getting the patient to stand and lean forwards over the observer, when palpation over the inguinal regions may reveal the existence of fluid. Or, by getting the patient to rest upon his knees and elbows in bed, fluctuation may be felt.

The form of fluctuation just described is sometimes spoken

of as *peripheral* fluctuation, to distinguish it from *direct* or *immediate* fluctuation. If a solid organ, usually the liver, or a solid tumour, lie a little distance from the surface of the abdomen in a case of ascites, and the fingers of the hand, applied perpendicularly to the surface, be suddenly depressed, the solid structure is felt, and at the same time a sense of displacement of fluid is conveyed to the fingers. This is known as the direct sense of fluctuation; it is sometimes spoken of as "dipping for the liver."

Encysted peritoneal exudation may give rise to no sense of fluctuation.

Friction vibration is sometimes felt in cases where the peritoneal investment of the liver or spleen becomes roughened by inflammatory exudation. As the visceral and parietal layers of the peritoneum move upon each other, a sensation of scratching or grating as in pleurisy may be developed. Friction is most commonly met with in carcinomatous disease, especially when attacking the liver.

Hydatid fremitus is a peculiar form of tense fluctuation, which is appreciable by the pleximeter finger when certain cysts, hydatid especially, are sharply perceived.

III. PERCUSSION.

Percussion of the abdomen is most conveniently practised when the patient lies upon his back. It may be employed, using the forefinger as a pleximeter, and striking it with the fingers of the other hand; or the hammer and ivory pleximeter may be used. The chief object of abdominal percussion is to define the outline of organs which are not within the range of palpation; to determine the condition of the stomach and intestines; and to ascertain the condition of the peritoneal sac. It is the last that will be considered here.

Condition of the Peritoneal Sac.—If a small amount of fluid be effused, so that it does not rise above the level of the pelvic cavity, no alteration takes place on percussion. When the abdomen is partially filled with fluid, dulness is heard on percussion over the lower parts of the abdomen. When the cavity of the peritoneum is distended, the dulness is marked at the sides, when the patient lies upon his back and over the anterior surface, except for a small area, irregularly rounded in form, which corresponds to about the centre of the abdomen. The dulness changes with the position of the patient, becoming clear in the uppermost flank when he lies upon his side, &c. In exceptional cases the resonant area in front is absent. This may be due to an extreme amount of effusion, so that the weight of the fluid is sufficient to press heavily upon the bowel and to a great extent empty it of air; or the mesentery may be so short as not to allow the intestines to float sufficiently so as to reach the surface. In other cases of ascites, resonance, irrespective of position, has been observed corresponding to Bamberger's space—*i.e.*, the space between the last rib and the crest of the ilium. In such cases the intestine has been fixed in position by antecedent inflammation.

Ascites may sometimes be difficult of detection owing to extensive œdema of the abdominal subcutaneous tissue. This not alone obscures palpation, but it may completely prevent any sign being elicited by percussion to indicate the existence of fluid in the peritoneum.

The disease which above all others is most likely to give rise to mistakes in reference to the diagnosis of ascites is ovarian dropsy, and it may be convenient here to tabulate the conditions which distinguish one from the other.

ASCITES	OVARIAN DROPSY
1. HISTORY. Uniform progressive enlargement.	1. HISTORY. The enlargement of the abdomen begins unilaterally, usually from one or other iliac fossa.
2. INSPECTION. Widening of the abdomen as the patient lies upon his back from the sagging out of its sides with fluid. Marked protrusion of the umbilicus, which is in its normal position ; caput medusæ ; marbled condition of surface.	2. INSPECTION. Rounded prominent swelling, projecting to the front, or towards one side of thc abdomen. Increased distance of umbilicus from pubes.
3. PERCUSSION. Whilst the decubitus is supine, dulness in both flanks ; resonance over centre of abdomen. Marked changc of percussion note on change of position.	3. PERCUSSION. The dulness is central, or confined to the situation of the tumour, whilst the surrounding parts yield a resonant note. Resonance in the flauks. No alteration by position.
4. NATURE OF FLUID WITHDRAWN BY ASPIRATOR. Sp. gr. 1010 to 1015. Like serum in appearance. Coagulates spontaneously when cxposed to the air.	4. NATURE OF FLUID WITHDRAWN BY ASPIRATOR. Sp. gr. 1018 to 1024. Deep amber coloured; often syrupy. Seldom or never coagulates.
5. MENSURATION. Greatest circumference at level of umbilicus.	5. MENSURATION. Greatest circumference at a few inches *below* level of umbilicus.

In addition to the points mentioned, Sir Spencer Wells observes that in ovarian dropsy the outline of the cyst may be felt at some point of its circumference, or, at least, when the patient draws a deep breath, a transverse line, corresponding to the upper border of the cyst, may be seen to descend.

IV. AUSCULTATION.

Auscultation of the abdomen cannot be said to be of much value in diagnosis, with one important exception—the auscul-

tation of the uterus in pregnancy, the sounds heard over this organ being those of the fœtal heart and the placental bruit.

The sounds of the fœtal heart are first heard towards the end of the fourth month of fœtal life. They are said to be most frequently heard towards the left side of the mother.

Placental bruit is a sound which is developed in the dilated uterine arteries, synchronous with the arterial pulse, and audible during the second half of pregnancy.

Friction murmurs in connection with peritonitis may be occasionally heard.

Hamburger recommends auscultation of the œsophagus during the act of swallowing as aiding the diagnosis of diseases affecting this tube. The cervical and thoracic portions may be examined. In the examination of the former, the stethoscope is placed upon the left side of the neck close to and behind the trachea, at a point between the hyoid bone and supra-clavicular fossa; the thoracic portion may be examined by listening with the stethoscope along the left side of the spine, from the level of the last cervical to the right dorsal vertebra. The main point insisted upon by Hamburger is that whilst in normal conditions, during the swallowing of fluid, a ringing gurgling sound is *at once* produced; in stenosis of the œsophagus the sound which follows deglutition is developed after an abnormally long interval, and in an enfeebled degree. This mode of examination needs to show some more definite degree of value before it can be said to recommend itself as a sign of physical diagnosis.

V. MENSURATION.

This method is employed chiefly to ascertain the progress of cases of ascites, and also as a diagnostic between this condition and ovarian dropsy.

EXAMINATION OF THE LIVER.

The methods employed in the examination of the liver are—Inspection, Palpation, and Percussion. Auscultation, as specially applied to the liver, may be left out of consideration.

Inspection.—It sometimes happens that a marked prominence in the right hypochondrium is produced by enlargement of the liver, the exact form and outlines of which can be seen when the abdomen is viewed either in front or in profile, and in such cases the liver may be observed sinking and rising in the abdominal cavity during inspiration and expiration. It is the sharp lower border of the organ which is specially discernible during the respiratory movements.

Palpation.—In adult men the presence of the liver in the right hypochondrium is indicated merely by an increased sense of resistance to pressure during deep inspiration; in persons who have very lax and thin abdominal walls, as in women who have had repeated pregnancies, the smoothness and laxity of the superficial tissues enable the soft edge of the organ to be felt under the ribs during its inspiratory descent.

Palpation of a normal liver may be effected with facility if it be displaced downwards. Displacements downwards may be caused by conditions which depress the diaphragm, such as right pleural effusion or pneumothorax, emphysema, extreme effusion into the pericardium; or it may be dislocated downwards by tight lacing. A rare condition of relaxation of the suspensory ligaments of the liver sometimes occurs which, with overstrain, as in severe labour, may displace the liver downwards, as far even as the anterior-superior iliac spine. This is described as *movable or wandering* liver.

Much more commonly can the liver be felt when it is *enlarged.* The enlargement may be moderate in extent and

uniform in distribution; it may be rough or smooth, painless or painful; it may be of extreme degree and involve either the greater or lesser lobe or merely a part of each.

In moderate enlargement the edge of the right lobe may be felt projecting one, two, or three inches below the margin of the ribs. This is met with in passive congestion, enlargement from retention of bile, fatty infiltration, and in the early stage of cirrhosis.

In extreme cases of enlargement the liver may fill the greater part of the abdominal cavity, as in cancer, amyloid or hydatid disease.

The surface of the enlarged liver and its edge may be smooth, as in congestion, fatty infiltration, amyloid disease, and simple hypertrophy; or it may be dense, rough, or nodular, as in cirrhosis, syphilitic hepatitis, and cancer.

Palpation of the liver may be painful or painless, and this condition affords grounds for the division of enlargements into *painless* and *painful.*

Painless enlargements.—The *painless* enlargements are (1) simple hypertrophy, (2) fatty infiltration, (3) amyloid degeneration, (4) hydatid disease, (5) the enlargement in connection with retained bile.

Painful enlargements.—The *painful* enlargements are—(1) congestion, (2) acute inflammation, (3) the early stage of cirrhosis, (4) perihepatitis, (5) abscess, and (6) cancer.

Percussion.—Percussion is employed to determine the position and size of the liver. It frequently, when the organ cannot be reached with the hand, affords important indications of disease, whilst, where evidence exists by palpation of extension downwards of the liver, the question of enlargement as distinguished from displacement may be settled by determining the *upper hepatic* boundary.

As a considerable part of the liver lies in contact with the chest wall, the note on percussion over this area will be absolutely dull, hence it is spoken of as the area of *absolute hepatic dulness.*

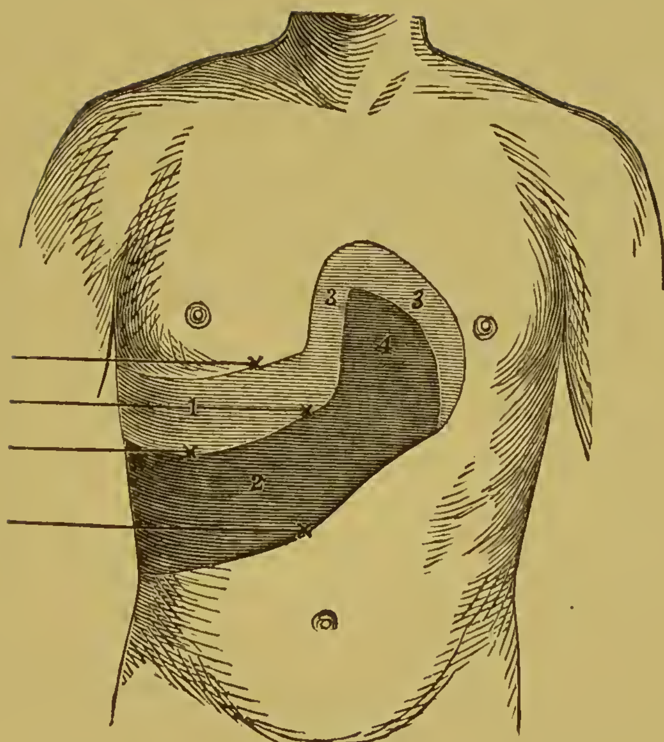
Above this area the liver is separated from the chest by a gradually increasing depth of lung, so that the note on percussion travelling from above downwards will indicate the part where the pulmonary tissue becomes encroached upon by the solid liver, the note becoming duller and duller until the acme of dulness is produced. This region or area is known as that of the deep or *relative hepatic dulness.*

Area of absolute hepatic dulness.—The *upper limit* corresponds at the right border of the sternum to the sixth rib; in the mammillary line it corresponds to the upper border of the seventh rib; in the axillary to the eighth rib; in the scapular line to the ninth rib. The dulness of the left lobe passes insensibly into the area of cardiac dulness.

The *lower limit* begins at a point close to the apex beat of the heart, crosses the front of the abdomen obliquely until it joins the margin of the costal arch at an acute angle in the mammillary line. As the line of dulness crosses from left to right it corresponds, in the centre line of the abdomen, to a point midway between the base of the ensiform cartilage and the umbilicus. As the dulness is traced to the side and posteriorly, it is found to correspond to the space between the tenth and eleventh ribs.

Area of relative hepatic dulness.—The upper limit of the area of relative hepatic dulness commences about the fourth intercostal space, or corresponds to the fifth rib, between the right mammary and parasternal lines. It may be stated generally that it lies about three inches above the upper limit of the area of absolute dulness.

Fig. 36.



Cardiac and Hepatic Dulness.

1. Relative hepatic dulness.
2. Absolute hepatic dulness.
3. Relative cardiac dulness.
3. Absolute cardiac dulness.

(Modified from Graham Browne.)

As the position of the liver varies with the respiratory movements, so also the position and extent of dulness vary on percussion. Deep inspiration depresses the lower edge considerably, whilst a corresponding elevation takes place upon forcible expiration. The change in the area of dulness is due in part to altered position of the liver; in part to the altered volume of the lung.

Very considerable alterations in the extent of hepatic dulness may take place without any alteration whatever in the size of the liver. Thus the organ may be encroached upon from above by emphysematous lungs, pleuritic effusion, or pneumothorax; it may be displaced upwards by conditions of increased pressure within the abdominal cavity, such as ascites, meteorism, ovarian cysts, &c.; or it may follow a shrunken right lung (cirrhosis of the lung).

In a rare class of cases the liver increases in size not only downwards but upwards to a considerable extent, reaching sometimes as high as the third intercostal space, dilating the right side of the chest and compressing the right lung. This enlargement is found generally associated with hydatid disease.

Diminution of the area of hepatic dulness, both relative and absolute, is met with in conditions of diminished volume of the liver—cirrhosis and acute yellow atrophy.

In cirrhosis the contraction of the liver cannot in many instances be ascertained by percussion, inasmuch as the presence of a large amount of ascites with which the condition is associated prevents the lower limit of hepatic dulness being ascertained whilst the pressure of the fluid displaces the liver upwards.

In acute yellow atrophy the area of hepatic dulness becomes progressively so diminished that pulmonary percussion sound may pass uninterruptedly into the tympanitic intestinal sound.

EXAMINATION OF THE STOMACH.

The methods of examination employed in investigating diseases affecting the stomach are—inspection, palpation, percussion, and auscultation.

Inspection.—On inspection, dilatation of the viscus, and tumours in connection with it, may be discernible.

Dilatation of the stomach frequently gives rise to a uniform, somewhat oval-shaped, swelling in the epigastric region, passing towards the left under the ribs, and so beyond the superficial boundary of the abdomen; if the dilatation be excessive there may be a marked prominence of the entire abdomen. This marked distension is always due to the presence of gas in the stomach, and in such a case the most marked peristaltic movements are observed occurring either spontaneously, or reflexly by rubbing or stroking the epigastrium briskly with the hand. A wave of contraction can often be observed passing from the cardiac orifice across the body of the stomach towards the pylorus, and affording a very perfect outline of the size, shape, and position of the organ. It is especially in dilatation associated with constrictive disease of the pylorus that this condition is markedly present.

Tumours of the stomach, either affecting the body of the organ or the pylorus, frequently form projections which are readily recognisable.

Palpation.—Palpation enables us to recognise the existence of tumours over any part of the stomach, but especially those which are situated at the pylorus. As a rule, however, tumours situated at the cardiac orifice, or occupying the lesser curvature, except they attain very considerable dimensions, are too deeply seated in the concavity of the diaphragm to be reached by the fingers. Tumours affecting the great curva-

ture are usually felt low down and to the right; tumour of the pylorus is most frequently felt above the umbilicus to the right. Epigastric tumours are not necessarily gastric in origin; they may spring from the left lobe of the liver.

Palpation further enables us to detect pain on pressure, or abnormal tenderness or resistance to pressure in the epigastrium. Localised pain, aggravated by pressure, is an important sign of gastric ulcer; diffuse pain over the entire region of the stomach is common to gastralgia (neuralgia of the stomach), acute or chronic catarrh, and malignant disease.

In cases of dilatation of the stomach, if fluid be present in it to any large amount, upon palpating with both hands distinct splashing sounds are produced. These are not necessarily an indisputable indication of dilatation, but they are of some importance, taken with other signs of the condition. It sometimes happens that an œsophageal bougie passed into the stomach may be felt within it on palpating the abdomen. If the point of the bougie be felt below the level of the umbilicus, assuming there is no displacement of the organ, it is evidence of dilatation (Leube).

Percussion.—Only a small area of the anterior surface of the stomach and the greater part of its greater curvature are in direct contact with the abdominal parietes, the rest of the organ being covered by the left lobe of the liver and the lower border of the left lung with the diaphragm intervening. The lower border of the stomach, that is its greater curvature, crosses the epigastrium from the left lobe of the liver to the left hypochondrium, in a curved line, situated nearly midway between the point of the xiphoid process and the umbilicus, inclines upwards and outwards, opposite the free end of the tenth rib, and at the level of the sixth rib in the anterior

axillary line, meets the upper boundary of the organ. These limits represent the stomach in a moderate state of distension.

Percussion can limit only those portions of the stomach which are not overlapped by other organs, and which are in immediate apposition with the anterior abdominal wall. In examining by percussion the patient should be placed on his back, and the lower limits of the liver on the right side and of the lung on the left, should be ascertained. The hepatic dulness and the clear pulmonary note give place to one which is distinctly tympanitic in character, provided the cavity of the stomach be moderately distended with air. The further delimitation of the stomach may be completed by ascertaining the position of the greater curvature which marks its lower border. There is, however, often a difficulty in localising the lower border in consequence of the close proximity to it of the transverse colon, the percussion sounds of the great intestine and of the stomach being almost alike in both intensity and pitch. It sometimes happens that the note on percussion over the colon is very much higher than that over the stomach, so that there is considerable facility in delimitating the lower border of the latter viscus.

The note on percussion over the stomach will, of course, present variations according as it is empty, overcharged with food, or distended with gas.

If empty, a clear and deep tympanitic sound is heard over the entire gastric area.

When overcharged with food, the tympanitic area is greatly diminished in extent, the dependent parts of the great curvature presenting a distinctly dull note, which affords a marked contrast to that heard on percussing the colon; the dulness, too, extends to the left hypochondrium, and masks that of the

spleen, whilst on the right side it merges into the dulness of the left lobe of the liver.

If the stomach be distended with gas, so that its walls are in a state of tension, a metallic quality is developed in the percussion note over a considerable area. Guttmann recommends that to elicit this sound percussion should be practised by striking the pleximeter with a *hard inelastic body*, such as the handle of the percussion hammer or a rod of metal, and that the ear should be kept close to the spot percussed.

Leichtenstern, who has elaborated this method of examination, holds that by means of the metallic note produced the exact dimensions of the stomach can be ascertained, but as the same note is often heard over the colon the value of the sign is more or less relative. Frerichs suggests a method by which the outline of the stomach can be traced on the surface with more or less accuracy. It consists in administering to the patient a quantity of tartaric acid, followed by a like quantity of bicarbonate of soda dissolved in water; the effervescence which is produced distends the stomach to such an extent as to render its outline visible, whilst a deep tympanitic percussion sound, with a metallic ring, can be elicited over the organ. A strange device, for the same purpose, has been suggested by Schreiber. He proposes to pass an œsophageal tube into the stomach, attached to which is a small india-rubber balloon; the balloon when it reaches the stomach is inflated through the tube, and the organ is in this way distended.

Another and more satisfactory method than either of the two last in determining the lower limit of the stomach is to get the patient to drink large quantities of fluid, water or milk, and to percuss the abdomen whilst he stands erect. If the dull note produced by the fluid extend below the level of the umbilicus the stomach is either displaced or dilated. By

changing the position of the patient the fluid may be made to gravitate into various positions if dilatation exist. Often by getting the patient to kneel in bed, with the head low and the hips well raised, we can define the boundary of the stomach by eliciting on percussion a dull note which contrasts with the surrounding tympany.

Auscultation.—Auscultation of the stomach and gastro-intestinal canal generally, reveals the existence of sounds of a splashing, gurgling, or metallic character, due to the agitation of fluid and air in a closed cavity. These sounds are familiar to every one; they are specially produced in the dyspeptic, in whom they are heard as loud rumbling noises; they are the ordinary signs of flatulency. The importance to be attached to ringing metallic râles developed in the stomach, lies in the liability which they present to the inexperienced of being mistaken for sounds developed in the lungs, especially when heard over the posterior part of the thorax. Their rapid disappearance, want of connection with the respiratory movement, existence during suspension of respiration, and audibleness over the stomach, should help in distinguishing them from respiratory sounds.

Bamberger points out that, in dilatation of the stomach, if one listens with the stethoscope over the stomach when the patient drinks, a distinct metallic sound can be heard when the fluid falls into the large cavern. Occasionally the sound produced is of a hissing character, like that heard upon opening a bottle of soda-water.

Two very rare sounds heard over the abdomen have been described by Tschudnowsky, and Laboulbène, and Gerhardt.

Tschudnowsky mentions that murmurs of a blowing amphoric character may be developed in cases of perforation of the bowel where the opening is sufficiently wide to permit of the

free entrance and exit of gases contained in the intestine and peritoneal cavity. The murmurs may be synchronous with the ascent or descent of the diaphragm ; or they may be heard, artificially produced, by making rapid pressure on the abdomen with one hand and listening with the ear applied directly to the surface, or through the stethoscope. Such sounds, however, have but little practical value, as the diagnosis of perforation of the intestine rests upon conditions which are more constant and reliable than the existence of intestinal murmurs. There are few physicians who, in such a case as intestinal perforation, would be disposed to elicit any sign which would be likely to cause disturbance of the intestine or its peritoneal investment. Such murmurs, when present, can have only a transient existence, as the occurrence of peritonitis causes a closure of the opening in the gut.

Laboulbéne and Gerhardt describe a ringing metallic splashing sound (*abdominal succussion*), which can be developed in peritonitis from perforation of the intestine, and where air and fluid exist in the cavity of the peritoneum. The sound is elicited by pressing firmly and quickly upon the abdomen, or on grasping it between the hands and shaking it. Such a procedure is, in our opinion, unjustifiable.

EXAMINATION OF THE SPLEEN.

The methods of examination of the spleen are those employed in the examination of the stomach—viz., inspection, palpation, percussion, and auscultation.

Inspection.—On inspection, ordinarily, no information is obtained in reference to the organ. If markedly hypertrophied (from leukæmia, intermittent fever, amyloid disease, &c.), it may give rise to fulness in the left hypochondrium, and the anterior edge of the organ may be observed to shift its posi-

tion during the respiratory movements; occasionally the enlargement is of such a size that the anterior wall of the abdomen throughout almost the entire of its extent is protuberant, and a distortion is produced which is specially noticeable on lateral inspection. The ordinary weight of the spleen is from four to ten ounces avoirdupois; but in extreme enlargements it may weigh as much as 18 lbs., 20 lbs., or even up to 40 lbs.

Palpation.—The spleen in its normal position cannot be reached by the fingers in palpation; it is only when it is displaced downwards by conditions which depress the diaphragm, or that it is enlarged that its edge can be felt deep in the left hypochondrium beyond the extremity of the eleventh rib.

Palpation of the spleen is best carried out by putting the patient in what is termed the splenic position, that is, by getting him to recline somewhat towards the right side, leaning chiefly on the right shoulder blade and right hip, and to have the left leg half flexed upon the abdomen. On placing the hand deeply in the left flank, under the ribs, the edge of the spleen, if the organ be moderately enlarged, will be felt to descend during inspiration. This manipulation can be sometimes aided by tilting the spleen upwards from the lumbar region with one hand whilst it is being palpated with the other. If considerably enlarged there is no difficulty as regards its palpation; it is felt to move upwards and downwards with the respiratory movements. Usually the enlargement is uniform, so that the spleen retains its shape, and the splenic notch can be distinctly felt—a point of diagnostic importance in reference to the organ enlarged. The enlargement is almost invariably smooth, except in cancerous infiltration, but varies considerably as to consistence. It is dense in leucocythæmia and in intermit-

tent fever; soft in passive congestion, and in the congestion of acute diseases, fever, &c. Palpation usually gives rise to no pain, except the capsule be inflamed.

Percussion.—The situation of the spleen is such that the long diameter of the organ inclines downwards and forwards, parallel with the lower ribs on the left side, its normal extent corresponding very closely with the space from the ninth to the eleventh rib. Its upper and posterior extremity lies opposite the tenth dorsal vertebra in the concavity of the diaphragm, one-third of the upper and hinder part being overlapped by the inferior border of the lung. The termination of the downwards and forward projection of the organ corresponds to the extremity of the eleventh rib.

Percussion of the spleen should be *superficial;* the organ is too thin for *deep* percussion, and it lies too near to air-resounding cavities, such as the stomach and colon. The stroke, too, should be delivered in the respiratory pause, as during inspiration the spleen is in great part sheltered by the lung. In percussing, the patient may be either standing, with his arm raised, or lying in the splenic position. The dulness is found to commence at the upper margin of the ninth rib, and to extend downwards to the eleventh rib, or to its lower border. Posteriorly the splenic dulness is bounded by the scapular line, between the ninth and the eleventh rib; here it merges insensibly into the dulness produced by the kidney and other structures in the loins. Its anterior limit coincides with the crossing of the ninth, tenth, and eleventh ribs by the mid-axillary line; the anterior and lower edge is about one and a half inches distant from the edge of the costal cartilages. The length of splenic dulness is usually about three inches; its breadth, at right angles to its length, is from two to two and a half inches.

Changes in the form and dimensions of splenic dulness are caused by displacement of the organ, or enlargement or atrophy of it. In very deep inspiration it is displaced downwards; so also in left pleural effusion, pneumothorax and pulmonary emphysema. In ascites and tympanitic distension of the stomach or intestines, the spleen is displaced upwards. In the former the existence of dulness produced by the presence of fluid will prevent the delimitation of the spleen. In the latter, as well as where there is emphysema of the lungs, all traces of splenic dulness are masked by resonance.

Conditions of the stomach have a very marked effect on splenic dulness. If the fundus be greatly distended with food, a dull note over the cardiac end will prevent the differentiation of splenic dulness. If the stomach be distended with gas, the gastric tympany completely masks the dull sound.

In certain cases the spleen may be *dislocated* from its position, owing to relaxation of the ligaments which hold it in position, and it may be found in various situations in the abdominal cavity, altering its position with every change in the posture of the body. Such a condition is known as *movable or wandering spleen.* Under such circumstances considerable changes, as far as palpation and percussion go, are to be noted.

The nature of splenic enlargements cannot be said to be determined accurately by either inspection, palpation, percussion, or by the three combined. The various conditions with which the enlargement is associated, the symptoms complained of, and other circumstances, must be taken into careful consideration in making a diagnosis of the nature of the enlargement.

The chief forms of enlargement met with are as follow:—

Amyloid.
Malarial.
Congestive.
Leukæmic.
Enlargement of Hodgkin's disease.
Hydatid enlargement.
Enlargement from tumours of various kinds.

Amyloid enlargement may be diagnosticated from the association of the disease with those causes which are known to give rise to amyloid disease—viz., profuse suppuration in connection with diseased bone, syphilis, and destructive disease of the lungs. It is most frequently co-existent with amyloid disease of the kidneys, liver, and mucous membrane of the intestines.

Malarial enlargement is associated with the signs, past or present, of intermittent fever.

Congestive enlargement may be of either the passive or active form. The passive form is one of the most constant signs of portal obstruction, especially when dependent upon cirrhosis of the liver. The active form of enlargement is met with in most infectious diseases. It constitutes an early and valuable sign of enteric fever.

Leukæmic enlargement is usually accompanied by swelling of the superficial lymphatic glands. Its nature is at once determined by a microscopic examination of the blood, which shows a great increase in the number of maturely-developed white blood-corpuscles.

The enlargement of the spleen in Hodgkin's disease (adenia, lymphadenoma) resembles that occurring in leukæmia in being accompanied by enlargement of the superficial lymphatic glands. It differs, however, from leukæmia, not alone in its clinical history, but in the important particular of not pre-

senting any alteration of the blood upon microscopic examination.

Hydatid enlargement can be only diagnosticated with certainty by microscopic examination of the contents of the cyst. Enlargement from tumours is rarely a primary disease; the diagnosis of its nature depends upon the clinical history and co-existing conditions.

Auscultation.—The only signs, in connection with the spleen, recognisable by auscultation, is an occasional friction sound audible in peri-splenitis, and a systolic murmur, which is sometimes to be heard over the spleen when enlarged in ague or leukæmia (Winkle and Hirschfeld).

EXAMINATION OF THE PANCREAS.

The physical signs which indicate disease of the pancreas are determinable only by palpation, and by inspection of the alvine discharges. The latter will be alluded to in the section dealing with the excreta. Tumours of the head of the pancreas can occasionally be felt to the right of the middle line, above the level of the umbilicus. The swelling is deeply seated, usually hard and nodular, not freely movable, and not influenced by the respiratory movements. The disease is seldom of limited extent. Neighbouring organs are usually affected, and a difficulty always exists in distinguishing what apparently is a tumour of the pancreas from tumours of the retro-peritoneal lymphatic glands.

EXAMINATION OF THE KIDNEYS.

Affections of the kidneys are almost invariably ascertained by a careful examination of the urine. In some cases inspection and palpation afford useful indications of disease.

Four conditions in connection with the organ may give

rise to signs appreciable by both inspection and palpation—viz., cancer, hydronephrosis, perinephritic abscess, and movable kidney. In each of these a smooth, bulging, or irregular swelling makes its appearance, causes a certain amount of alteration in the contour of the renal region, and presents alterations which are appreciable by palpation. In a floating kidney, the size, uniform shape, great mobility, and distinct presence of a hilum render the diagnosis more or less certain.

Percussion of the kidneys can scarcely be said to afford any material aid in diagnosis, inasmuch as most diseases of the organ are unattended with any great diminution in size. Where there is a very considerable decrease in size, as in cirrhotic kidneys, the diagnosis of the affection depends upon an examination of the urine and a careful analysis of the symptoms and secondary effects produced; and lastly, where there is very considerable increase in the size of the organs, that increase is, as a rule, readily determined by inspection and palpation. Its only advantage as a means of diagnosis is in movable kidney, where there *might* be an absence of dulness over the lumbar region corresponding to the side of the displaced kidney.

Percussion of the Kidney.—The rules laid down for delimitation of the kidneys are as follows:—The patient should be laid prone, the abdomen being supported upon cushions. The upper portion of either kidney cannot be limited, as its dulness passes insensibly into the liver or the spleen. The internal border lying next the spinal column is also incapable of limitation. The outer border lying parallel to the spinal column, and about three finger-breaths distant from it, can be defined from the resonance of the adjacent part.

EXAMINATION OF THE INTESTINES.

The examination of the intestines needs here but a few words. The methods employed in investigation of diseased conditions of these viscera are like those used in affections of the stomach.

Inspection may reveal great tympanitic distension, such as is present in enteric fever or peritonitis. There may be a retracted condition of the abdomen, such as exists in basilar meningitis, a condition already referred to (see page 215).

Palpation is employed chiefly to ascertain the condition of the bowels with regard to their contents, to detect the existence of tumours of various kinds in connection with the intestines or omentum, and to elicit the expression of pain or tenderness in connection with inflammatory affections.

Large, hard fæcal accumulations of doughy consistence may be felt over any part of the front of the abdomen, frequently in the right and left iliac regions, or corresponding to the situations of the transverse colon. Very frequently pain or tenderness on pressure is complained of in the right iliac or inguinal region; a hard flag is felt in the situation. The condition is associated with inflammation in the loose cellular tissue surrounding the cæcum—*perityphlitis.*

The normal percussion note over the intestines, both large and small, is *tympanitic*, usually being higher in pitch than the percussion note of the stomach. The intestinal note is subject to great variation both in health and disease, according to the variable condition of the bowel with regard to fluid and gaseous contents, and also to a varying degree of tension in the abdominal wall.

In ascites, where the intestines are compressed, the note may become acutely tympanitic.

When the bowel is tensely inflated with gas, the abdominal note becomes deeper in pitch, but not tympanitic, as in typhoid fever and peritonitis. The same alteration in pitch occurs physiologically after the taking of a full meal.

Solid matters lying within the bowels necessarily give rise to a dull tympanitic sound, which may become absolutely dull if the fæcal accumulation be large in quantity.

Von Ziemssen recommends that for the purpose of mapping out the form and position of the bowels, especially in the case of a stricture of the gut, they should be distended with gas formed in the rectum by the mixing of a solution of bicarbonate of sodium with one of tartaric acid.

Auscultation in connection with the intestines has been incidentally referred to in the section on the examination of the stomach.

CHAPTER XI.

EXAMINATION OF EXCRETA.—THE URINE: ITS GENERAL, PHYSICAL, AND CHEMICAL CHARACTERS.

The points to be noted in the examination of the urine are as follow:—

1. Quantity.
2. Colour and transparency.
3. Odour.
4. Reaction.
5. Specific gravity.
6. Normal and abnormal constituents.

1. *Quantity.*—The quantity of urine passed varies within wide limits, even in health, and depends to a great extent upon the quantity of fluids ingested, and the degree of activity of the cutaneous transpiration. It bears also a relation to the alvine discharge. An average range in health may be estimated at from forty to fifty ounces in the twenty-four hours.

The quantity is increased pathologically in the two forms of diabetes (mellitus and insipidus); in some nervous affections of a paroxysmal nature, especially hysteria; and generally in conditions where the blood-pressure is increased in the vessels of the Malpighian tufts, and the rapidity of the flow of blood through them is accelerated.

The quantity is *diminished* in all affections which lessen the pressure of the blood in the renal arteries and retard its flow, as in uncompensated heart disease; in some forms of renal disease; in febrile affections; in the collapse stage of cholera;

and in conditions which unduly lessen the fluidity of the blood, such as profuse sweating, or copious watery discharges from the bowels in diarrhœa or other allied affections. In uncompensated heart disease there is an alteration of the relative degrees of tension in the arterial and venous system. The valvular defect lessens the amount of blood which passes into the aorta, whilst an abnormally large amount is retained in the veins. This leads to reduced tension in the renal arterioles; hence a reduction in the quantity of urine secreted. The same reduction of tension affecting the arterial system generally is brought about by those conditions which markedly reduce the volume of the blood—cholera, diarrhœa, extreme sweating, &c.

2. *Colour and Transparency.*—Normally the colour of the urine varies from a pale lemon-yellow or clear amber to yellowish-red, the different tints depending upon the amount of pigments present, and the degree of concentration of the urine.

Vogel calculates that there are eight parts per thousand of colouring matter in amber-coloured urine, and sixteen parts per thousand in yellowish-red urine. His scale of tints is generally adopted as follows:—

Yellow urines	Pale yellow. Bright yellow. Yellow.
Red urines	Reddish-brown. Yellowish-red. Red.
Dark urines	Brownish-red. Reddish-brown. Brownish-black.

In fevers the colour is deepened from concentration and probably from an increased amount in it of red colouring matter. It is pale in colour in diabetes, or in conditions where the pigment is deficient, as in all forms of anæmia; in convalescence from acute disease; and after a hysterical seizure (urina spastica).

The principal abnormal colouring matters found in urine are bile-pigment, blood, urobilin, and uroerythrin (urochrom). The presence of bile-pigment in urine has already been discussed in the section on jaundice (page 28).

When blood is present in urine the latter acquires a tint, the depth of which depends on the amount of the abnormal element present. If freely diffused through the urine the colour of the mixture may be reddish-brown or brownish-black; if the bleeding be very profuse the colour is that of blood itself. When small in amount, so as not to impart any distinctive colour, it leaves a sediment which is characteristic: on tilting gently the chamber vessel to one side a reddish-brown granular-looking substance may be observed in the vessel, lying just within the edge of the fluid, and shifting its position as the fluid is moved from side to side.

When no sediment is present the existence of blood can be ascertained by a microscopical examination of a drop of the urine taken from the bottom of a vessel in which it has been allowed to stand for a time, or often from the bulk of the fluid itself. The blood-cells are found to be altered in shape, being usually distended and pale in colour or shrivelled in appearance and having crenated edges. Some care must be exercised in distinguishing them from spirilla (Beale), the discoid forms of oxalate of calcium, and, perhaps, the nuclei of renal epithelium. Theoretically, the presence of blood in the urine should be indicated by that of albumen, but the ordinary tests for

albumen may fail to show its existence when blood-corpuscles are observed under the microscope.

In some cases the urine may be stained red by the colouring matter of the blood, and yet no blood-cells are to be found in it. The colour of the urine in such cases is pinkish, though it may be dark red or chocolate-brown in hue. The microscope reveals only the existence of a granular *débris* and the presence of hæmoglobin in roundish yellow drops, variable in size, and bead-like in appearance. When the urine containing hæmoglobin is heated it yields a coagulum which floats upon the surface instead of sinking, as in the case of albumen, being composed of the proteid of hæmoglobin and destitute of serum albumin. The condition just described is termed *hæmoglobinuria.* It is the result of a disintegration of the red corpuscles with a liberation of their colouring matter. It occurs from various conditions—in animals, from the transfusion of the blood of one kind into another of a different species; in man, from sunstroke, scurvy, septic fevers, or the action of various poisons, such as hydrochloric acid, sulphuric acid, chlorate of potassium, nitrobenzol, naphthol, carbolic acid, and arseniuretted hydrogen. Peculiar forms of the affection have been met with, occurring in infants—*infantile hæmoglobinuria;* and in adults, where it tends to recur frequently—*paroxysmal hæmoglobinuria.*

Tests for Blood in Urine.—Heller's Test.—The common chemical test for blood is known as that of Heller. It consists in rendering the urine alkaline by the addition of caustic potash or soda, and then boiling so as to precipitate the earthy phosphates, the precipitate carrying down any blood-colouring matter (hæmatin) which the urine may contain.

Guaiacum Test.—Another test for blood consists in adding to a small quantity of the suspected urine a drop of recently pre-

pared tincture of guaiacum, and then to shake up the mixture with a few drops of ozonic ether. If blood be present a brilliant blue colour is acquired by the layer of ether which lies upon the surface of the urine when it has been allowed to stand for a few moments. It is well, however, to bear in mind that saliva, nasal mucus, and iodide of potassium give the same reaction. When equal parts of tincture of guaiacum and oil of turpentine are shaken together so as to make an emulsion, and the urine containing blood is cautiously added, an intense blue colour is produced.

Spectroscopic Test.—In doubtful cases the presence of blood in the urine may be recognised by *spectrum analysis.* The slightest trace of oxyhæmoglobin in the fluid is shown by the presence of two strongly-marked absorption bands lying between the solar lines D and E in the yellow and green of the spectrum. If the urine containing blood be kept for a time but one absorption band is to be observed, lying between the C and D lines. This represents the presence of *Methæmoglobin*, one of the products formed in the reduction of oxyhæmoglobin into hæmatin and albuminous matters.

Blood in the urine may be derived from the urethra, when it is usually indicated by the presence of a long thin clot which, precedes the discharge of urine. When it is poured out into the bladder or derived from the prostate gland it is frequently present in clots, and the urine voided first is often clear, that voided last is loaded with blood. When derived from the kidney it is uniformly mixed with the urine, which frequently contains in addition bloody tube casts.

Other pigments which cause discoloration of urine are urobilin and uroerythrin.

Urobilin was first separated by Jaffé.* It is a reddish

* Virchow's Archiv. Vols. XLVII. and XLVIII.

pigment resembling bilirubin, and is allied to hæmatin. It is found in the fæces, to which it gives its brownish colour. It exists in the urine in fever and in jaundice. Hoppe-Seyler states that urobilin is not found in normal urine, and he demonstrates its close relation to blood pigment by showing that when hæmatin in alcoholic solution is treated with tin and hydrochloric acid, urobilin is formed. The tests for urobilin in urine are three:—

1. On spectroscopic analysis, urine containing it shows an absorption band between Frauenhofer's lines *b* and *F*, shading away towards *F*. When the band is not well defined, if the urine be shaken up with ether, the ethereal solution of the pigment will show the spectrum.

2. A green fluorescence is produced in an alkaline solution of urobilin upon the addition of a small quantity of chloride of zinc.

3. The addition of ammonia to an acid solution of the pigment, or to acid urine containing it, changes the reddish colour into clear yellow.

Uroerythrin (purpurin of Golding Bird) is a pigment which gives to sediments of uric acid and urates their yellowish-red or brick-red colour. It is found in the urine of persons suffering from fever, hepatic disease, and occasionally in healthy persons from slight errors in diet, &c. Uroerythrin may be regarded as an oxidised form of the special pigment of the urine—*urochrom.*

Transparency.—When healthy urine is passed it is perfectly clear and transparent, but after standing for a time it becomes slightly turbid, from the presence in it of a flocculent mucus which gradually subsides to the bottom. When the urine is concentrated a cloud of urates is deposited when it becomes cool; occasionally the mucus entangles at the surface crystals

of oxalate of calcium producing a well-defined whitish-looking scum.

It sometimes happens that urine is passed containing small whitish-looking bodies, of irregular shape and flocculent appearance, and about the size of the head of a small pin. These bodies are found to be made up of leucocytes, and are met with in persons who have had gonorrhœa or prostatitis.

Phosphates may be passed in urine in quantity so as to render it more or less turbid, the turbidity resembling that produced by the presence of lithates. Heat affords a means of distinguishing the two sediments, one from the other. Heat dissolves the urates and renders the urine clear; if phosphates be present, the urine becomes more turbid. The addition, however, of a few drops of acid to urine rendered cloudy by phosphates clears it completely.

Speaking generally, turbidity of the urine when it is passed is due to the presence of earthy phosphates, mucus, pus, or blood. The first is removed by the addition of a few drops of acetic acid. Turbidity due to pus is distinguished from that due to mucus by the presence of albumen with the former, its absence with the latter. The presence of albumen may be recognised by the addition of one or two drops of a clear solution of ferrocyanide of potassium to the urine previously acidulated with acetic acid. If the turbidity be not increased mucus is present; if it be increased, it is due either to pus or to mucus existing in albuminous urine. If the sediment formed be collected and treated with caustic potash, it will, if pus, be converted into a tough, thick, gelat nous fluid which flows with difficulty from the vessel; if mucus, it will not become thick or coherent. Turbidity due to the presence of blood can be ascertained by employing the guaiacum test.

The discoloration of urine from the presence in it of indi-

can, melanin, &c., and its turbidity from the presence of chyle, will be referred to further on.

Urine is frequently discoloured, incidentally and temporarily, by the use of certain medicines. After rhubarb and senna it often becomes brownish-red, from the formation of chrysophanic acid. It may become black after the administration of carbolic acid or the use of tar ointment. It becomes yellow from the use of santonine.

3. *Odour.*—The odour of urine is said to be faintly aromatic when recently passed. After being kept for some time, when alkalinity is developed, it becomes ammoniacal. This is due to the conversion of its urea into carbonate of ammonia by the catalytic action of mucus and bacteria. When urine contains blood or pus, a putrefactive odour is generated from rapid decomposition setting in.

When turpentine is taken internally, the urine has the smell of sweet violets. Various resins, such as copaiba, cubebs and tolu, communicate their peculiar smell to urine. It is also influenced by the use of asparagus. In diabetes mellitus the urine has often a sweetish odour, and, where acetonæmia sets in, it may smell like chloroform.

4. *Reaction.*—Fresh normal urine is acid in reaction, the acidity being due to the acid phosphates which it contains, as well as to free organic acids—lactic and hippuric acids. It may perhaps be due also to free uric acid and acid urates.

The degree of acidity varies considerably, even in health. After a meal it may become neutral or even alkaline, and its reaction may be amphoteric or amphigenous—that is, red litmus paper is turned blue, and blue litmus is turned red. Normally, the degree of acidity is estimated by the intensity of the reddening of blue litmus paper. In amphoteric urine it is probable that basic and acid phosphates exist

together. The diminished acidity of urine during digestion is due to the absorption into the blood of alkali, produced by the digestion of the citrates, tartrates, malates, &c., derived from the food; hence it is least acid after meals consisting largely of fruits and of other substances in which salts of the vegetable acids are present.

The acidity of the urine is increased by a flesh or milk diet, by muscular exercise, by drinking, by the use of acids, in fevers, and in diabetes mellitus.

It is diminished during gastric digestion, by an exclusively vegetable diet, and by the use of alkalies or their salts with vegetable acids. When kept for some time urine first becomes more strongly acid, then less acid, and finally alkaline. The increased acidity is due to acid fermentation, probably caused by an organism similar to yeast, which leads to the formation of acid phosphates, and of lactic and acetic acids from the urinary extractives. The alkalinity is due to the alkaline fermentation caused by bacteria, mucous corpuscles, and epithelia, by which the urea is converted into carbonate of ammonia. There can be no doubt but that bacteria play a very important part in rendering urine decomposed and alkaline. Fresh urine, to which bacteria have been added, undergoes a very rapid change; and the same effect has been often produced in urine within the bladder by inoculation through the use of dirty catheters.

5. *Specific Gravity.*—The specific gravity of urine is estimated by means of the urinometer. The instrument is dipped into the urine, and the graduation upon the stem read off, corresponding to the upper level of the urine. The graduations on the stem reach from 1000, the sp. gr. of distilled water, usually up to 1050. The normal sp. gr. of urine varies from 1015 to 1025, being largely influenced by the amount of

fluid ingested. After taking a large amount of fluid it may be as low as 1005; after profuse perspiration, as high as 1035.

In taking the sp. gr. there are certain points to be attended to:—1. The temperature of the urine should be that of an ordinary room, about 60° F. 2. The instrument should be dried before use. 3. It should be kept free from the sides of the glass vessel containing the urine.

If the quantity of water be too small to sufficiently fill the cylindrical glass it may be diluted with a quantity of distilled water sufficient to fill the cylinder to the required height. From the sp. gr. of the mixture that of the urine may be calculated. Thus, if it be necessary to add four times as much water as urine—that is, to make five volumes—and the sp. gr. of the mixed fluid is 1004, then that of the urine is $1000 + (4 \times 5) = 1020$. The last figure (or figures) of the sp. gr. is multiplied by the number of times the urine has been diluted, and the result is added to 1000.

From the sp. gr. of the urine a rough estimate can be formed as to the quantity of solid matter it contains, and from the entire amount passed in the twenty-four hours, the amount of solids excreted daily. This is obtained by multiplying the last two figures of the sp. gr. by the coefficient of Trapp, 2; or, still better, by that of Hæser, 2·33. Either of these will give approximately the number of grms. of solid matter in 1000 c.c. (33·8 f. oz.).

Thus, taking the sp. gr. to be 1022, and using Hæser's coefficient,

$$22 \times 2{\cdot}33 = 51{\cdot}26 \text{ grms. in } 1000 \text{ c.c.}$$

As the whole quantity of urine passed in twenty-fours is 1200 c.c., the formula will run—

$$1000 : 1200 : : 51{\cdot}26 : x = \frac{51{\cdot}26 \times 1200}{1000} = 61{\cdot}51 \text{ grms., or}$$

948·09 grains.

The urine is of high sp. gr. in diabetes mellitus, after copious perspiration, vomiting or purging, and as a rule after convulsive seizures. In diabetes the sp. gr. may vary between 1030 and 1060.

The urine is of low sp. gr. in diabetes insipidus (chronic diuresis), in cirrhotic disease of the kidney, exposure to cold, under the influence of diuretics, and in conditions which interfere with general nutrition (anæmia, cachexia, &c.).

6. *Normal and abnormal constituents :—*

The normal constituents of urine may be classified under four heads—

1. Nitrogenous substances — urea, uric acid, kreatinin, xanthin, allantoin, &c.
2. Ferments—pepsin and ptyalin.
3. Salts—chlorides, sulphates and phosphates of sodium, potassium, ammonium, calcium, and magnesium.
4. Acids—oxalic, lactic, sulphuric, glycero-phosphoric, &c.
5. Pigments and pigment-yielding bodies or chromogens.

Perhaps a simple division dealing with the most important elements is that which tabulates the elements into—

Organic substances.

1. Urea.
2. Uric acid.
3. Kreatinin.
4. Indican.

Inorganic substances.

1. Chlorides.
2. Sulphates.
3. Phosphates.

Organic substances.

1. *Urea.*—Urea is the chief organic constituent of urine, and represents mainly the ultimate metamorphosis of albumen and the other nitrogenous elements which are found in the body. It varies in quantity with the amount and composition of the ingesta, and with the activity of tissue metamorphosis in health and disease. As urea forms the great bulk of the solids present in urine an approximate idea as to its amount in any given specimen may be arrived at by ascertaining its sp. gr. This, however, will be correct only when the chlorides are present in their normal quantity and the urine contains neither sugar, nor albumen, nor excess of water. To estimate accurately the quantity of urea present, the mode now almost universally adopted is by what is known as the hypobromite process, first introduced by Davy and modified by Hüfner.

Hypobromite process for quantitative estimation of urea.—This method depends upon the principle that urea in contact with alkaline hypobromites or hypochlorites is decomposed and gives off nitrogen, from the amount of which the quantity of urea decomposed may be readily estimated. A solution of hypobromite of soda is made in the following proportions:—Caustic soda, 100 grms., is dissolved in water and the solution diluted up to 1250 c.c. To this 25 c.c. of bromine are to be added, and the mixture shaken vigorously. The solution is to be kept well stoppered and in a dark place. It can used be only when freshly prepared, as it decomposes very readily.

The apparatus used for the test is that introduced by Russell and West. It consists of a tube in which the urine is allowed to mix with a hypobromite solution, and a pneumatic trough with a measuring tube, in which to collect the evolved

gas. The measuring tube is graduated to give the percentage of urea.

A rough means of estimating the quantity of urea consists in adding an equal part of nitric acid to urine in a test tube and placing it in cold water. If the urine contains *an excess of urea*, crystals of nitrate of urea will at once make their appearance.

The quantity of urea excreted in the twenty-four hours by a healthy adult averages from 300 to 500 grains. It is largely increased by the taking of nitrogenous food, though a limit to this increase is apparently fixed by the tendency which such food has, when taken in great excess, to produce diarrhœa, and so lighten the excretory function of the kidneys. Urea is considerably increased in diseases attended with elevation of temperature, as in fevers, pneumonia, acute rheumatism, &c., and in diabetes mellitus. It is largely decreased by an exclusively farinaceous dietary, and in the various forms of Bright's disease. In inflammatory affections of the kidney, and especially in cirrhotic renal disease, the reduction of the quantity of urea excreted frequently affords indications of the advent of most serious disturbances.

The term *azoturia* has been applied to a condition in which the excretion of urea is excessive in proportion to the weight of the body. Excessive excretion of urea, both absolute and relative to the amount of urine, may occur in perfectly healthy persons, for a time, and pass away without giving rise to any trouble. In other cases, however, the excess of urea is associated with gastro-intestinal disturbance and nervous symptoms. Amongst the latter may be mentioned restlessness, irritability of temper and depression of spirits, great langour and a feeling of neurasthenia, dull pain in the back, and a nervous irritability of the bladder, with a greatly increased

tendency to micturition. Dr. Lauder Brunton gives an intelligible explanation of these symptoms. He points out that in many individuals nitrogenous tissue change occurs with abnormal rapidity, and that such persons require a larger proportion of nitrogenous elements in their food than others to enable them to do the same amount of work; when indigestion occurs the nitrogenous products of imperfect digestion or tissue waste, acting as nervous and muscular poisons, lead to the symptoms mentioned.

Fig. 37.

Usual forms of uric acid crystals. (After Harley.)

2. *Uric Acid.*—This acid does not exist free in urine, but in combination with sodium, potassium, ammonium, calcium, and magnesium—the salt formed by its union with sodium being the most common. All urates are much more soluble in warm than in cold solutions; hence, urine which is clear when passed deposits a cloud of urates upon cooling, which can be redissolved readily upon the addition of heat. Uric acid itself may be easily obtained from urine upon the

addition of hydrochloric acid, when it is found deposited in the form of lozenge-shaped crystals. This form is, however, considerably modified by rounding and aggregation, being sometimes observed in rod-like bodies, or producing stars and spikes; sometimes as rounded off, spindle or barrel-shaped, or in the form of dumb-bells.

Murexid Test for Uric Acid.—A small portion of uric acid sediment, or the residuum of urine after evaporation, is warmed in a porcelain capsule with a few drops of nitric acid and a little water, and the solution is carefully evaporated over the flame of a spirit lamp. When almost dry a drop or two of liquor ammoniæ is added with a glass rod taken out of the solution, when a beautiful reddish-purple colour makes its appearance, which, on the addition of a few drops of caustic potash, changes to a purplish blue.

The total quantity of uric acid excreted in twenty-four hours is from a half to one gramme. It varies with the amount of urea, to which it bears the proportion of 1 to 50 or 60. It is increased by the conditions which increase the amount of urea excreted. In a gouty paroxysm it is diminished, but afterwards it is increased. It is excreted in increased amount in hepatic disturbances, in some forms of indigestion, in leucocythæmia, and in acute rheumatism.

3. *Kreatinin.*—Although a normal constituent of urine, kreatinin cannot be said to have any practical significance. It is excreted in larger quantity than uric acid—usually one gramme *per diem.* It is passed in an increased amount in typhus and pneumonia, and in diminished quantity in anæmia, chlorosis and tuberculosis.

Test for Kreatinin.—To a small quantity of urine add a few drops of a very dilute solution of nitro-prusside of sodium, and subsequently a little dilute caustic soda, a beautiful

ruby-red colour develops, which soon passes into deep straw-yellow.

4. *Indican.*—Probably the most important colouring matter found in urine is indican. It is found in small quantity in normal urine (6·6 mgrm. in 1000 cc.), but especially in dark yellow urines, in which, upon the addition of nitric acid, the dark violet colour of indigo is produced. Indigo-blue was first observed in connection with urine by Prout, but the constant presence in urine of *indican* was specially noticed by Schunck, who thought that this colourless substance was identical with the indican of plants, which readily passes into indigo-blue by oxidation. Recent investigations go to show that the indican of urine is not the same as vegetable indican, but that it is an indoxyl-sulphate of potassium ($C_8H_6NKSO_4$. Baumann). It is identical with the uroxanthin of Heller, It is a derivative from indol, which appears to be formed within the intestines as a result of a change in the albumen produced by the pancreatic ferment. Jaffé has detected large quantities of indican in the urine in cases of obstruction of the small intestine, and in strangulated hernia; and in dogs after ligature of a loop of small intestine. He has also made it appear in the urine of dogs fed upon indol, or when that substance had been injected subcutaneously.

Senator* and Heniger† have devoted considerable attention to the conditions under which an excess of indican is met with. Senator finds it chiefly in conditions of inanition, such as are associated with cancer of the stomach, gastric ulcer, multiple lymphomata, phthisis with diarrhœa, &c. Heniger insists that the excess is specially marked in cases where wasting is dependent upon disease of the alimentary canal. Probably

* Centralblatt, 1877.

† Deutsches Archiv, 1879.

the most important clinical point in connection with the presence of a large quantity of indican in urine is that it is associated with obstruction of the small intestine; where the large intestine is engaged, no such augmentation takes place.

Tests for Indican (Jaffé).—Add to the urine an equal volume of hydrochloric acid, and then pour in, drop by drop, a solution of chloride of lime, shaking the fluid well, and adding no more of the chloride after a greenish colour begins to appear. If any considerable quantity of indican is present, a blue colour will soon show itself, and if the quantity is very large, indigo-blue will be deposited in flocculi.

A substance closely allied to indol has been described by Brieger as being a frequent constituent of urine—viz., skatoxyl-sulphate of potassium; it is derived from skatol, which, like indol, is formed from a decomposition of albuminous substances within the intestines. Both indol and skatol have a strongly fæcal odour. Jaffé's test with hydrochloric acid and chloride of lime gives a reddish violet instead of a blue colour, when skatoxyl-sulphate is present.

INORGANIC SUBSTANCES.

1. *Chlorides.*—Chlorine in urine exists in combination with sodium, potassium, ammonium, magnesium, and calcium. The presence of chlorides may be demonstrated by adding to the urine a few drops of a solution of nitrate of silver, when a white flocculent precipitate of chloride of silver is thrown down. The quantity of chlorides depends chiefly upon the amount of salt taken with the food, the average quantity of chlorine excreted in twenty-four hours being 10 to 12 grammes.

The most important clinical indication in connection with the chlorides is their retention in the system in acute inflam-

matory affections, especially pneumonia. Baumann* holds that the diminution is due to a change in the relation of the albumen of the blood to the chloride of sodium in the plasma, and not to a decrease in the amount of chloride of sodium taken with the food.

2. *Sulphates.*—Sulphur appears in the urine as sulphuric acid, free, or in conjunction with organic radicals; as oxidisable sulphur compounds, like taurin; and as sulphur compounds which are only with difficulty oxidisable. They are all formed from the breaking up of the albumen of the tissues, or that derived from the food.

Test for Sulphates.—Acidulate the urine strongly with acetic acid, and then add chloride of barium, a white precipitate of sulphate of barium, which represents the union of the sulphuric acid with the alkalies, will be thrown down.

The amount of sulphuric acid in urine will be increased or diminished according to the amount of albumen which is broken up, corresponding with the amount of urea and uric acid excreted; the average amount in twenty-four hours is about two grammes.

3. *Phosphates.*—Phosphoric acid is met with in urine in the form of phosphate of calcium, ammonio-magnesian or triple phosphate, and as phosphate of sodium and potassium. It may also appear as glycerin phosphoric acid and lecithin. It is derived in part from the food, in part from the breaking down of tissues which contain phosphorus, viz., the osseous and nervous tissues.

Phosphates are deposited in feebly acid urine on the application of heat in the form of a whitish cloud, which may be mistaken for albumen. A drop of acid added to the urine at once removes the cloud, if it be phosphatic. It has been sup-

* Zeitschrift für kl. Med. Vol. I., p. 513.

posed that this cloud was due to the heat driving off the carbonic acid which helped to retain the phosphates in solution. It is probable, however, that the precipitation of the phosphate of calcium by heat depends upon an adjustment of the proportions and basicity of the phosphatic salts in the urine.*

It was formerly held that "phosphatic urine" indicated an undue waste or disintegration of nervous tissue, and that it was specially to be met with in those who undergo a great amount of brain work. Such persons, however, take but little exercise, and the urine is, as a rule, diminished in acidity, which explains the precipitation of the phosphates. When exercise is taken, the phosphates disappear.

The amount of phosphates in urine may be roughly estimated by rendering it alkaline with ammonia, and then adding to it an ammonio-magnesian solution. A precipitate of ammonio-magnesian phosphate *at once* occurs if the amount in the urine be normal, but is delayed if the quantity be below the normal.

Phosphates are found in increased quantity in urine in diseases of the bones and nervous system. The earthy phosphates are specially increased in osteomalacia.

ABNORMAL CONSTITUENTS OF URINE.

These may be classed under the following heads:—

1. Albumen.
2. Sugar.
3. Blood.
4. Bile Pigment.
5. Bile Acids.
6. Urinary Sediments—Organic and Inorganic
7. Urinary Pigments.

* See paper dealing with this point, by Dr. Walter G. Smith, M.D., Dub. Jour. Med. Sci., 1883.

1. *Albumen.* The most constant and the most important of the abnormal substances met with in the urine is albumen. It forms the chief sign in the recognition of Bright's disease, hence the necessity of closely investigating the way in which it makes its appearance in the urine, its general characters, and the tests employed for its detection.

Albumen as it is found in the urine in Bright's disease is composed of the two forms which are present in the liguor sanguinis—viz., "Serum-albumin," and "Serum-globulin" or "Paraglobulin." The serum-albumin can be completely separated from the paraglobulin by Hammersten's method, that is to add to the urine magnesian sulphate in the form of a white powder; the globulin can be removed as a white flocculent precipitate.

Both paraglobulin and serum-albumin react to the nsual tests for albumen, and no practical advantage is gained by drawing a distinction between the two forms.

It seems to be admitted that the most constant, if not the only condition which explains the appearance of albumen in the urine in Morbus Brightii, is a nutritive change in the epithelium covering the glomeruli which permits the escape of albumen from the blood. Although Stokvis and Bartels maintained that albuminuria was mainly due to increased blood-pressure in the renal arterioles, the investigations of Cohnheim and Runeberg go to show that all evidence—both experimental and pathological—is wholly against this view, and the last-named observer holds that albuminuria is *always* dependent upon a *deficiency* of blood-pressure.* This is readily understood when one considers the mode of occurrence of albuminuria in uncompensated heart disease, and the intermittent albuminuria met with in ascites.

* Deutsch Archiv. für kl. Med. Vol. XXVI.

A form of albuminuria known as "physiological" albuminuria has had much attention directed to it of late. It represents the transient occurrence of albumen in the urine in persons apparently in good health. A number of such cases have been recorded by Leube,* Fürbringer, Bamberger,† George Johnson,‡ Moxon,§ Sir William Gull, and others. The condition is an intermittent or occasional one, and is most commonly caused by the application of cold to the surface, causing congestion of the kidneys. Recently German authorities are disposed to hold that it depends upon a congenital deficiency in the power of the glomerular epithelium to resist the passage of albumen through it. The great importance to be attached to such cases lies in the determination as to whether or not the occurrence of albuminuria indicates a tendency to Bright's disease. This is not the place to discuss such a question at length; it may suffice to say that there is no reason why the temporary presence of albuminuria should necessarily lead to a prognosis of the development of organic disease. It is not an uncommon thing to find that persons of a gouty habit—if indiscreet in living, especially as regards the taking of wine—pass, for some days after the indiscretion, urine containing a small quantity of albumen. It is by no means certain that in such cases the albumen comes from the kidneys; it may be exuded from the vessels of the bladder, just as a similar exudation may take place as a result of the irritation produced by cantharides. If the urine be examined it will be found that it contains most albumen when the bladder is nearly empty, or that the last part of the urine passed is most albuminous.

* Virchow Archiv. 1878.
† Deutsch Archiv. für kl. Med. Vol. XXVII.
‡ Clin. Soc. Trans. Vol. VII.
§ Guy's Hospital Reports for 1878.

Tests for Albumen.—Four tests are ordinarily employed, the most common being those by heat and nitric acid.

1. *Heat Test.*—Fill two-thirds of a test-tube with the suspected urine, hold it by the bottom, and apply the upper portion of the fluid to the flame of a spirit-lamp; if the urine be acid, the albumen will be precipitated. The temperature at which this occurs varies with the amount of albumen present (Sir William Roberts). If the urine contain much earthy phosphate a cloud will also be formed by heat, but this is immediately dissipated by the addition of a drop or two of acetic acid. It should be borne in mind that if the urine be alkaline the albumen may not be precipitated by boiling, hence the necessity of first ascertaining the reaction of the specimen.

2. *Nitric Acid Test.*—Pour a small quantity of pure nitric acid into a test-tube, hold the tube in a slanting position, and then let a little urine slide down the side until it floats upon the surface. If albumen be present, a distinct line of opalescence marks the junction of the acid and the urine. If no albumen be present, a more or less deep layer exists between the two fluids from oxidation of the chromogen. If the amount of albumen present be very small, a considerable time may elapse before the cloud makes its appearance, hence, in doubtful cases it is well to let the test-tube containing the acid and urine stand for a time. Urine containing a large quantity of urates may yield a precipitate upon the addition of nitric acid; this at once clears off upon heating the specimen. So, likewise, a faint cloudiness is produced by the addition of the acid to the urine of patients taking copaiba or cubebs. Heat partially, and the addition of alcohol wholly, removes this.

3. *Ferrocyanide Test.*—To the urine in a test tube add one or two drops of acetic acid, and then a small quantity of a solution of ferrocyanide of potassium. If albumen be present it is thrown

down as a white flocculent precipitate. Dr. Pavy's pellets of citric acid and the ferrocyanide are a convenient form for applying the test.

4. *Picric Acid Test.*—Dr. George Johnson strongly advocates this test, which, however, has no advantage over the nitric acid test, except that the picric acid solution is more portable. The test is applied as follows:—To a saturated solution of picric acid, contained in a test tube, add drop by drop some of the albuminous urine; each drop as it passes through the solution is followed by an opaque white cloud.

The daily loss of albumen is extremely variable, especially in different forms of Bright's disease; in the inflammatory form from 10 to 26 grammes *per diem* may be lost, the urine being so loaded as to become solid upon boiling. In cirrhotic disease the amount may be barely appreciable. A rough way of estimating the amount of albumen present is to boil the urine and allow the precipitated albumen to subside fully. The quantity is estimated by expressing the depth of the precipitate at a half, a fourth, an eighth, &c., of the entire amount of fluid in the tube.

Quantitative Estimate.—To determine with absolute accuracy the amount of albumen excreted the precipitate should be separated from a known bulk of the fluid, washed, dried, and weighed. This is altogether outside the range of ordinary clinical observation. Sir William Roberts proposes a method which is simple and yields sufficiently satisfactory results. It consists in diluting the urine with water until it almost ceases to give a reaction with nitric acid, the point fixed being that at which the opalescent zone at the junction of the two liquids begins to be visible, between thirty and forty-five seconds after the addition of the acid to the urine. To calculate the number of grains of albumen per fluid ounce of urine all that is necessary is to multiply the figure 0·0034 by the number of

dilutions with an equal bulk of water that the urine has undergone.

The chief conditions in which albumen is met may be summarised thus:—

1. In great venous obstruction depending upon heart or lung disease.

2. In the various forms of Bright's disease.

3. In fevers where there is very high temperature it is occasionally observed.

4. In certain nervous disorders, as following an epileptic seizure, or in eclampsia.

5. In diabetes mellitus, without concurrent Bright's disease. It is here most probably due to irritation of the albuminuric centre in the medulla.

6. In ascites, in an intermittent form.

Besides the forms of albumen described, other forms are occasionally observed in urine, such as propeptone, peptone, and fibrin.

Propeptone is a peculiar albuminous substance found by Bence Jones and Virchow in the urine of those suffering from mollities ossium. Although precipitated by nitric acid in the cold, it is dissolved upon heating the urine.

Peptone.—This is a peculiar form of albumen which is not precipitated by acetic acid or ferrocyanide of potassium, but is thrown down by tannic acid and other reagents. According to Maixner,* peptone appears very frequently in the urine in those diseases attended with the formation and collection of pus, such as empyema, abscesses in various situations, bronchiectasis, phthisis with cavities in the lungs, &c.

Fibrin in the urine is usually present in the form of flakes, and is either due to inflammatary disease of the urinary passages, or is present with chyle in chylous urine.

* Prager Vierteljahrschrift, CXLIII. 1879. P. 78.

2. *Sugar.*—An extremely minute quantity of sugar is found in healthy urine, but in quantity so small as to be unappreciable by the ordinary tests. An appreciable amount of sugar in the urine constitutes the condition known as glycosuria, one of the most prominent signs of saccharine diabetes, or diabetes mellitus.

Urine containing sugar is usually very pale in colour—faintly yellowish with a tinge of green; it is perfectly clear, transparent, and free from sediment; sp. gr. 1030 to 1040, or even 1060; and passed in quantity up to 10, 12, or 15 pints in twenty-four hours. There is a form of diabetes specially described by Senator in which the quantity of fluid excreted is not increased—diabetes decipiens. With the sugar excreted there is also an increased excretion of urea, due in part to an excess of nitrogenous food ingested, in part to increased tissue change.

The qualitative tests usually employed for the detection of sugar are four in number :—1. The caustic potash test (Moore's). 2. Trommer's test. 3. Test with Fehling's solution. 4. Fermentation test.

1. *Caustic Potash Test* (Moore's).—Add to a small quantity of the urine in a test-tube an equal amount of liquor potassæ, and boil the upper portion of the solution. If sugar be present the heated portion acquires a dark brown colour, deepening to black if boiling be continued and much sugar be present. If to the coloured fluid a few drops of nitric acid be added, the brown discoloration disappears and the odour of caramel or of burnt molasses is developed. The colouration is due to the formation first of glucic and afterwards of melassic acid, both of which remain in solution. There are, however, some fallacies in connection with the test which should be noted. Almost all urines darken somewhat when the test is employed ; if the liquor potassæ contain lead, a brown or

black colour will be produced on boiling it with healthy urine; the colouring matters of the bile if present in the urine will turn it black upon the addition of the alkali.

2. *Trommer's Test.*—Add to the saccharine urine in a test-tube a few drops of a solution of sulphate of copper, and then an excess of liquor potassæ, until the whole fluid assumes a beautiful clear dark-blue colour. This colour is alone an indication of the presence of sugar. On heating the mixture, an *orange yellow* or *brick-red* precipitate is gradually formed, which in a short time falls to the bottom of the test-tube—this deposit is the *suboxide of copper.* The reaction which takes place is as follows:—The sulphuric acid of the sulphate of copper unites with the caustic potash to form sulphate of potash; the sugar is oxidised at the expense of the oxide of copper, which is thus reduced to the insoluble suboxide, and so is precipitated.

3. *Test with Fehling's Solution.*—Fehling's solution, as modified by Dr. Pavy, is made by taking 640 grains of neutral tartrate of potassium and 1,280 grains of caustic potass, and dissolving both in ten fluid ounces of distilled water; 320 grains of sulphate of copper are dissolved also in ten ounces of distilled water. The solution of the sulphate of copper is poured into that of the potassium salt, and the resulting liquid is of a deep-blue colour.

The test is thus employed:—A drachm, or thereabouts, of the solution is poured into a test-tube, and heated until it begins to boil; a drop or two of the urine is then added, and, if no change is observed, a further quantity of urine, until it equals that of the copper solution. The fluid is then heated up to boiling point; and, if the urine contain any sugar, the liquid, before it cools, will be found to have deposited a yellow or red sediment of the suboxide of copper.

4. *Fermentation Test.*—This depends upon the fact that saccharine urine, when mixed with yeast, ferments, yielding

CO_2 and alcohol. A small quantity of yeast is added to urine which fills a test-tube; this is covered with a saucer and inverted, and kept in position by a clasp. If sugar be present, CO_2 will collect at the upper part of the test-tube.

Quantitative estimation of Sugar.—Two methods of estimating the quantity of sugar excreted may be given—one by volumetric analysis, and the other by circular polarisation.

Volumetric Process.—This process is carried out usually by the use of Pavy's modification of Fehling's solution. The principle of Pavy's method is to ascertain how many minims of urine will be required to reduce the whole of the suboxide of copper in 100 minims of Pavy's copper solution. 100 minims of the solution, equivalent to half a grain of sugar, are measured with a pipette into a porcelain capsule, and diluted with an equal bulk of distilled water. Into this is dropped a fragment of caustic potash, about twice the size of a pea, for the purpose of causing the reduced oxide to fall in a denser form, so that the liquid may remain clear and allow the change of colour to be more readily seen. The capsule is then placed over the flame of a spirit lamp until it boils; a pipette, graduated to hold 100 minims, with sub-divisions, is charged with urine, and this is allowed to flow, drop by drop, into the boiling copper solution, which is kept constantly stirred with a glass rod. If sugar be present, the yellow and red oxide of copper gradually appears in greater quantity; but as soon as it is formed it settles, leaving the liquid still blue. At length, however, the blue colour is entirely removed, being replaced by an orange or an orange-red. At the moment this occurs the operation is suspended, and a glance at the pipette shows how much urine has been used. The copper solution, as has been stated, is of such a strength that exactly half a grain of sugar is required to decolourise 100 minims of it. Thus there is half a grain of sugar in the quantity of urine

that has been dropped from the pipette, so that a simple calculation at once determines the amount of sugar that must be contained in each ounce of urine and in the whole amount excreted daily.

Circular Polarisation.—This is an estimation of the quantity of sugar, based upon the property which grape sugar has, when in solution, of rotating a beam of polarised light passing through it, to the right. Probably, the best instrument for expeditious use for this purpose is the saccharimeter of Soleil-Ventzke. When using the instrument the nonius is so arranged that it points to zero on the scale, and upon looking through the instrument the two halves of the disc observed are of exactly the same tint. If the tube containing the diabetic urine be placed *in situ*, it is at once noticed that the halves of the disc are of different colours, and it is only by rotating to the right the milled head that the two quartz prisms are made to compensate for the disturbance in colour caused by the sugar solution, and each lateral half now presents the same tint. The amount of movement necessary to effect this is read off the scale by means of a vernier. Using a tube one decimetre long, each degree of the scale represents a gramme of grape sugar in 100 cc. of urine.

In employing either of these tests two points must be attended to—first, to free the urine from all traces of albumen; and, secondly, to collect the entire urine passed in twenty-four hours.

In certain cases of diabetes the urine acquires a peculiar sweetish ethereal odour like that of chloroform. This is due to the presence of acetone (C_3H_6O dimethyl-ketone), which is sometimes associated with a train of symptoms known as diabetic coma or acetonæmia. It should, however, be borne in mind that forms of diabetic coma may exist independently of the presence of acetone, and, on the other hand, acetonæmia

may be present unaccompanied by cerebral symptoms* (Dr. Dreschfield). Acetone gives a peculiar odour to the breath, which resembles a mixture of alcohol and ether. Its existence in the urine is ascertained by adding to it perchloride of iron; if acetone be present a bright crimson colour is produced, the reaction being due to the presence of ethyldiacetic acid, which readily breaks up into acetone, alcohol, and carbonic acid (Geuther and Gerhart).

A peculiarity with regard to urination has been observed in diabetes mellitus—viz., that it takes place at a longer period after the ingestion of fluid than normal. This is accounted for by taking into consideration the very high specific gravity of the blood in saccharine diabetes, and the diminished quantity of serous exudation into the tissues. Under such circumstances, when fluid is absorbed by the blood, it is immediately abstracted by the tissues, and it is only when it is again returned into the circulation that it becomes filtered off in the urine.

Inosite.—Occasionally, in alternation with grape sugar, inosite, or muscle sugar ($C_6\ H_{12}\ O_6$) makes its appearance in urine. It is detected by precipitating the urine first with neutral lead acetate, then with basic acetate, collecting the second precipitate on a filter, suspending it in a little water, and decomposing by hydric sulphide, filtering, and evaporating to a small bulk. A drop is then mixed with nitric acid, and evaporated almost to dryness on platinum foil. A drop of ammonia and one of calcium chloride are next added, and the whole is gently evaporated to dryness. A rose-red tinge indicates the presence of inosite. This substance has no action upon polarised light; it does ferment with yeast, and it is incapable of reducing copper,

Inosite is found in the urine, not only in diabetes mellitus,

* Bradshaw Lecture, Lancet. August, 1886.

but also in that of diabetes insipidus, sometimes in Bright's disease, or even where the kidneys are normal in structure. It is supposed that its presence is due to an excessive transudation of water through the tissues. Strauss discovered it in the urine of three healthy persons, who, for the purpose of experiment, had drunk a large quantity of water.

ORGANIC DEPOSITS.

The organic elements of an abnormal nature found in urine are—(1) blood, (2) bile, (3) pus, (4) epithelium, (5) tube casts, (6) spermatozoa, (7) fatty matter, (8) micro-organisms.

1. *Blood* in urine has been already referred to (p. 243).

2. *Bile.*—For the methods of detecting bile pigment and bile acids in urine, see p. 28.

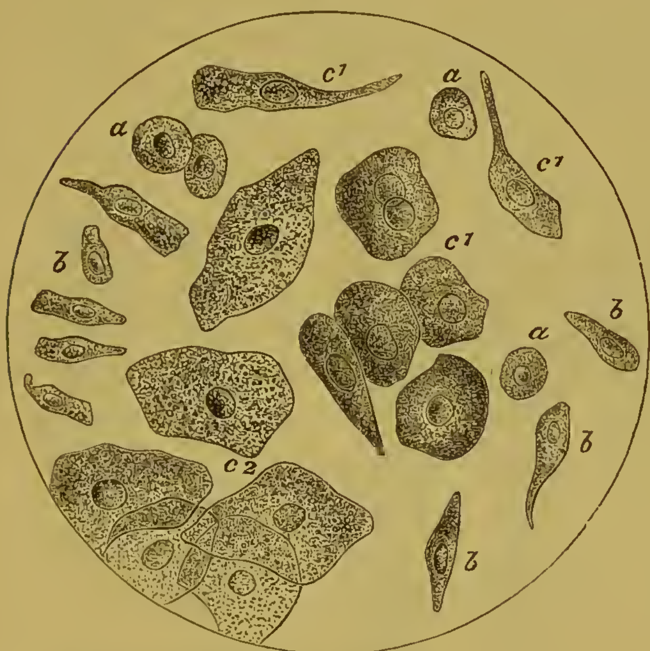
3. *Pus* is detected in urine by its forming a yellowish white deposit, which microscopically shows white blood corpuscles unaltered in shape, unless the urine be strongly alkaline, when they have a tendency to fuse together into a homogeneous mass. If a small portion of caustic potash be added to a deposit of pus and the sediment stirred with a glass rod, it becomes converted into a tenacious and semi-solid mass.

Pus corpuscles are found in the urine in greatest number in catarrh of the bladder, also in catarrh of the pelvis of the kidney and of the mucous membrane of the ureter and urethra. When it comes from the bladder it is mixed freely with large vesical epithelial cells.

4. *Epithelium.*—Epithelial cells may be detached from any part of the urinary apparatus, and present differences in appearance, according to the part from which they are derived. The epithelium of the urinary tubules consists of rounded or polygonal cells, having a large and sharply defined nucleus, sometimes separated from each other, and sometimes adherent; those of the pelvis of the kidney are

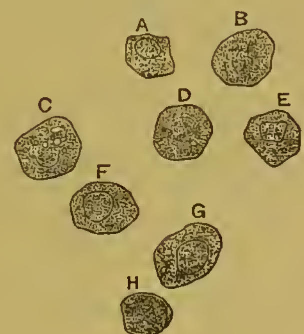
conical, with one or two tail-like processes; the vesical cells are large, with a single nucleus (like the buccal pavement epithelium), polygonal and more or less rounded at the angles. Below the superficial pavement epithelium of the bladder are numerous small spindle-shaped, or columnar cells, found when the catarrh involves the deeper layers of the epithelium of the mucous membrane. For the purpose of examination the cells may be stained with eosin or fuchsin.

Fig. 38.



a. Round epithelium from bladder.
b. Columnar epithelium from ureter and urethra.
c^1. Columnar and squamous epithelium from deeper layers of epithelium of bladder.
c^2. Squamous epithelium from superficial layers of epithelium of vagina.

Fig. 39.



Round epithelial cells from the convoluted tubules of the kidney found in urine from a case of acute nephritis. × 420. The cells A, E and H are slightly more granular than in health, and C contains a few oil-drops.

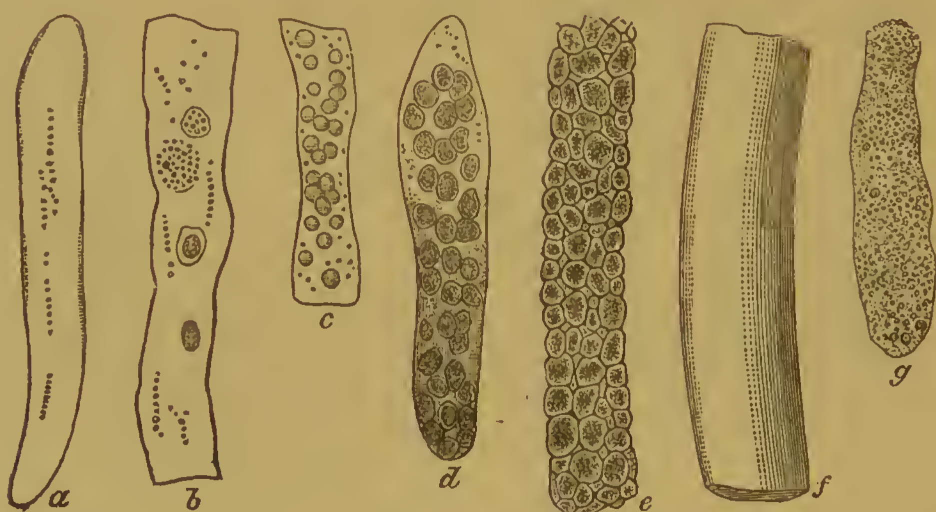
(From Tyson).

5. *Tube Casts.*—In examining for tube casts the urine should be allowed to stand in a conical vessel, so as to allow the sediment to be deposited and to be withdrawn with a pipette for microscopic examination.

Tube casts (moulds of the uriniferous tubules) are supposed by some observers to be formed by a process of secretion from the epithelial cells of the urinary tubules; by others, to arise from a fusion together of altered epithelial cells which are shed. The most common variety of tube cast—viz., the hyaline cast, is in all probability formed by the coagulation of fibrinogen exuded from the glomeruli, just as exudation is poured out in a case of plastic or "croupous inflammation."

The forms of tube casts met with are—(*a*) hyaline casts, (*b*) epithelial casts, (*c*) granular casts, (*d*) blood casts, (*e*) pus casts, (*f*) waxy casts, (*g*) fatty casts.

Fig. 40.



Differnt Forms of Casts.

a. Hyaline cast with occasional granules. *b*. Hyaline cast with fat-drops and granular cells. *c*. Hyaline cast with red blood-corpuscles attached. *d*. Hyaline cast with white blood-corpuscles attached. *e*. Epithelial cast. *f*. Waxy cast. *g*. Cast with a large number of fat-drops.

(*a*) Hyaline tube casts are delicate, homogeneous, and transparent; structureless, and so little refractile as to be often scarcely recognisable. Hence the advantage of using eosin,

carmine, or anylin stainings. They are formed, for the most part, in the convoluted tubes; hence, their tortuous appearance. Occasionally, these tube casts are of very large size, and exhibit the amyloid reaction, becoming dark brown on the addition of iodine, and dirty violet on the further addition of sulphuric acid.

(*b*) Epithelial tube casts are formed by cells detached from the convoluted tubes; the cells are more or less granular, or "cloudy" in appearance, larger than, and different in shape from, white blood-corpuscles.

(*c*) Granular casts are, next to hyaline, the most common and least destructive variety, as the granular appearance may be the result of disintegration of the blood discs, of epithelium, or they may represent fat granules.

(*d*.) Blood casts represent fibrinous cylinders filled with red blood-corpuscles. Their presence indicate hæmorrhagic exudation, usually of an inflammatory type.

(*e*.) Pus casts are cylinders containing white blood-corpuscles embedded in them; they are regarded by Dr. George Johnson as diagnostic of glomerulo-nephritis.

(*f*.) Fatty, or oil casts, are studded over with highly refracting oil drops. The fatty particles represent degeneration of the renal epithelium, such as occurs in the advanced stage of parenchymatous nephrites.

The existence of tube casts in urine, especially when associated with the presence of blood or pus, is an important indication of the presence of renal disease. It should, however, be borne in mind that the existence in the urine of tube casts, with albumen alone, may be merely an indication of slight and temporary changes in the glomeruli, which occur in association with pyrexia or temporary venous congestion.

6. *Spermatozoa.*—These bodies sometimes appear in the urine of healthy men. They preserve their normal appearance for a considerable time, but very rapidly render the urine alkaline.

Fig. 41.

Human spermatozoids. 1. Magnified 250 diameters. 2. 800 diameters. *a*, Viewed from the side ; *b*, from the front.

7. *Fatty matter.*—Small traces of fat dissolved in normal urine have been found by Schunck. In disease it is generally met with in a condition of the urine described as *chyluria.* This remarkable condition, which was first described by Prout, consists in the passage of urine having a milky appearance, emitting a strong milky, or whey-like odour, and coagulating, after standing for a short time, into a more or less solid mass resembling *blanc-mange.* In a few hours the clot breaks down; a material like cream collects upon the surface, when a deposit is formed of a pinkish colour due to the presence of a small quantity of blood. The sp. gr. varies from 1007 to 1020. Shaken up with ether the urine loses its milk aspect; albumen is thrown down upon the application of heat and nitric acid. Microscopically the opacity is observed to be due to the presence of a fine granular material,

composed of albumen and fat, and identical with the molecular base of the chyle. Chyluria is almost invariably met with in tropical and sub-tropical climates, and has been found to be due to obstructions in the lymphatic vessels caused by the presence in them of minute living organisms representing the embryos of a nematoid worm, the *Filaria sanguinis*. Sometimes the ova of the filariæ pass into the small lymph channels, and as the anastomosing paths become one after the other obstructed, a more or less complete stasis of lymph takes place, and if this occur upon the surface of some part of the urinary mucus membrane chyluria results. The stasis frequently happens in the lymphatic vessels of the scrotum or leg, giving rise to what are termed *lymph scrotum*, and *elephantiasis*, *Arabum*, or *Barbadoes leg*.

In very rare instances cholesterine plates have been found in urine.

8. *Micro-organisms*. The micro-organisims met with in urine are bacteria (chiefly those of decomposition, the *sphero-bacteria* or *micrococci*, the *microbacteria*, and the *desmobacteria*, or leptothrix form); yeast or sugar fungus (saccharomyces urinæ); *penicillium glaucum*; *sarcinæ urinæ* (similar to the sarcinæ ventriculi of Goodsir); embryos of the *filaria sanguinis*; and of the *Bilharzia hæmatobia*.

Fig. 42.

a. Sarcinæ ventriculi. *b*. Yeast cells.

The filaria sanguinis has been referred to in discussing chylous urine.

The Bilharzia hæmatobia is a small trematoid worm, which was discovered in 1851 by Bilharz. It has a special tendency to settle in the bladder, and gives rise to hæmaturia. Parasitic hæmaturia has been met with most frequently in Egypt, the Mauritius, and the Cape of Good Hope.

Inorganic Deposits.

These may be classified under two heads—viz., those met with in acid urine and those found only when the reaction is alkaline.

The deposits met with in acid urine are:—

(*a.*) Amorphous urates of potassium and sodium.
(*b.*) Crystals of uric acid.
(*c.*) Oxalate of calcium.
(*d.*) Leucin.
(*e.*) Tyrosin.
(*f.*) Cystin.

(*a.*) Urates of sodium and potassium occur in the well known form of a brick dust deposit, which usually stains the vessel in which it is thrown down. The sediment is mainly amorphous; its reddish colour is due to the urates being mixed with uroerythrin. The sediment is formed in the urine when it becomes cooled, and can at any time be dissolved by heat.

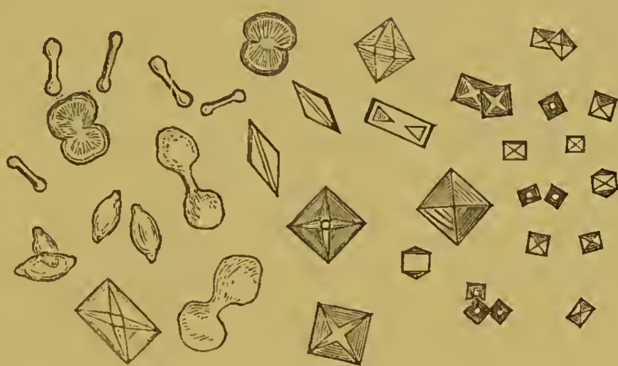
This deposit may be met with in healthy persons in the urine passed after profuse perspiration. In disease it is met with chiefly in febrile conditions, affections of the liver, dyspepsia, and in acute rheumatism.

(*b.*) *Crystals of Uric Acid.*—Uric acid occurs usually in the form of bright reddish looking grains, resembling cayenne pepper, which adhere to the sides or bottom of the vessel. The crystals may take the form of four-sided tables, or six-

sided rhombs; or they may be lozenge-shaped, ovoid, barrel-shaped, or arranged in a stellate fashion.

Reference has already been made to conditions relative to elimination of uric acid.

Fig. 43.



Crystals of Oxalate of Calcium.

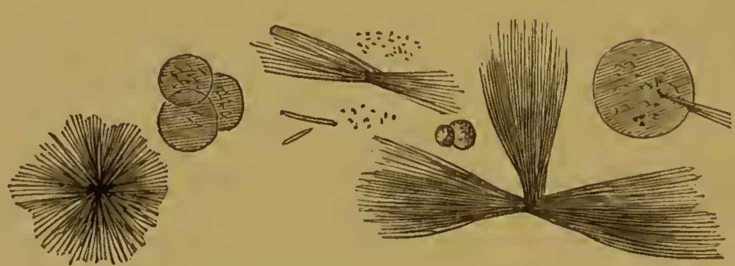
(*b*) *Oxalate of Calcium.*—Crystals of oxalate of calcium are most frequently met with in acid urine with those of uric acid, though they may be found in alkaline urine alongside crystals of the triple phosphate. Oxalate of calcium is usually entangled in flocculi of mucus, which may be observed some distance from the bottom of the glass in which the urine is contained. The deposit occurs in two forms, *octahedra* and dumb-bells. The former represent two four-sided pyramids, placed base to base when viewed in their longer diameter; when seen in the opposite direction, the appearance is that of a square, crossed obliquely by two bright lines. The dumb-bells are much more rarely met with—their name indicates their shape.

Oxalate of calcium exists normally in the urine in minute quantities, and is increased by the taking of sugar, or vegetables and fruits which contain sugar. It represents probably one of the last stages in the decomposition of the effete tissues,

resulting from impeded metamorphosis (Beucke). It is most frequently found in dyspepsia, and usually in persons who are thin, nervous, hypochondriacal, and irritable. Pain in the back is frequently complained of, irritability of the bladder, and muscular weakness. It not infrequently happens that large quantities of oxalate of calcium crystals are present in the urine without giving rise to any unpleasant symptoms whatever.

(*c*) *Leucin* and (*d*) *tyrosin* are crystalline bodies which occur rarely in the urine when it is loaded with bile. They have been most frequently observed in acute yellow atrophy of the liver, phosphorus poisoning, and in some fevers. Leucin occurs in the form of more or less yellow-tinged, highly refracting spheres, marked with radiating and concentric striæ. Tyrosin appears in the form of sheaves of silky, glittering, needle-shaped crystals.

Fig. 44.



Crystals of leucin and tyrosin.

(*d*) *Cystin* ($C_3H_5NSO_2$) appears in the urine in the form of crystals made up of regular six-sided tablets of different sizes, so arranged that a small one is superimposed upon a larger one, this upon one still larger, and so on. It may exist in both acid and alkaline urine, and develop in decomposition sulphuretted hydrogen, derived from the large amount of sulphur contained in the crystals (26 per cent.). The clinical significance of cystin is a matter of doubt. It has been

observed to occur in the urine of persons very nearly related, and, except that it may form calculus, it has been known to exist in the urine for years without giving rise to any form of disturbance.

Fig. 45.

Crystals of cystin.

Deposits in Alkaline Urine.—The chief inorganic deposits met with in alkaline urine are:—(*a*) Amorphous phosphate of calcium; (*b*) crystalline phosphate of calcium (stellar phosphate); (*c*) phosphate of ammonium and magnesium (triple phosphate); (*d*) phosphate of magnesium; (*e*) carbonate of calcium; (*f*) urate of ammonium.

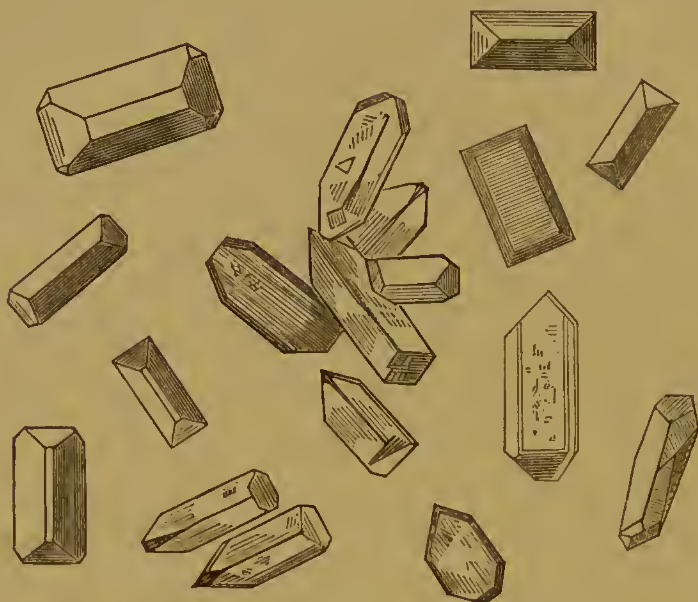
(*a*) *Amorphous phosphate of calcium* occurring in the form of minute granules is met with as a white flocculent deposit, soluble in the addition of one or two drops of nitric or acetic acid. It is always present when urine becomes ammoniacal, though frequently deposited from normal urine, in which it is kept in solution by the acid phosphate of sodium and CO_2.

(*b*) The *crystalline* form of *phosphate of calcium* occurs in the form of rods, which either lie separately or are united so as to form rosettes. This is a much rarer form than the preceding.

(*c*) *Phosphate of ammonium and magnesium* (*triple phosphate*) is met with always in ammoniacal decomposition of urine. It occurs as a crystalline deposit, of which the typical

form is a triangular prism with bevelled end, of large size and easily recognised.

Fig. 46.



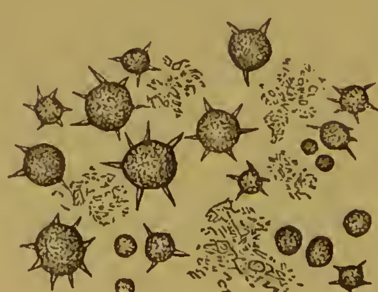
Crystals of the triple phosphates.

(*d*) *Phosphate of magnesium* occurs very rarely in urine in the form of crystals—flat, elongated, and clear in appearance.

(*e*) *Carbonate of calcium.* In the urine of the horse carbonate of calcium appears as crystals, spherical in shape, and marked with radiating lines. In human urine it occurs in the amorphous state.

(*f*) *Urate of ammonium* is present only in strongly ammoniacal urine. It occurs in the form of small brownish spheres, sometimes smooth on the surface, at other times covered with minute spikes.

Fig. 47.



Spherules and spiculated spherules of urate of ammonium (sodium ?); amorphous granular urates.

CHAPTER XII.

EXAMINATION OF THE EXCRETA (*continued*).—VOMITING.

By the act of vomiting is meant the forcible expulsion of the contents of the stomach through the œsophagus. The simultaneous contraction of the diaphragm and abdominal parietes and the relaxation of the muscular fibres at the cardiac orifice of the stomach cause the contents to be ejected from the stomach. The act of vomiting may be produced by direct irritation of the gastric mucous membrane or by the action of emetics, poisons, nauseous substances, violent shocks in the epigastrium, &c.; or it may be due to irritation of the nerve centre in the floor of the fourth ventricle, in close relation to the origin of the vagus nerve and the respiratory centre. It is probable that the co-ordination of the muscles engaged in vomiting is effected by this centre, and its close relationship to the respiratory centre is shown by the close resemblance between the act of vomiting and respiratory acts, and also by observing the action of emetics, which excite the respiratory centre before they induce vomiting. It has also been noted that depression of the activity of the respiratory centre arrests vomiting (Lauder Brunton).

Vomiting may be regarded as a reflex act in which afferent impressions of a varied and widespread nature may excite the nerve-centre in the medulla. These impressions may be of a purely sensory nature, and it is remarkable that disturbances affecting any one of the different senses may give rise to vomiting. Thus it may arise from the sight of some disgusting object, it may be caused by a bad smell, or some nauseous

taste; it is frequently associated with disease affecting the internal ear (Menière's disease); it may arise from painful impressions on the sensory nerves, as in the case of a dislocation of one of the semilunar cartilages, &c. Certain different nerves have apparently a more direct disturbing influence upon the vomiting centre than any others. They are given by Dr. Lauder Brunton, as follows :—

1. Branches of the glossopharyngeal nerve which supply the back of the tongue, palate, &c. The contact of the finger or a feather with the back of the throat is generally attended with an attempt at vomiting.

2. The nerves of the stomach. Familiar instances of the effect of irritation of these nerves is shown by the usual result of the retention in the stomach of undigested food, irritants taken into the stomach, &c.

3. The nerves of the liver and gall-bladder. Vomiting is a constant sign of gall-stone colic.

4. Intestinal nerves. Vomiting is a constant symptom of intestinal irritation, ileus, hernia, intussusception, fæcal accumulations, &c.

5. The renal nerves. Vomiting is a usual sign in nephritis and in renal colic.

6. Vesical nerves. Vomiting is not an uncommon sign of cystitis.

7. Uterine nerves. Irritation of these nerves is probably one of the commonest causes of vomiting.

8. Ovarian nerves. Vomiting is regarded as one of the signs of ovaritis.

9. The nerves of the testicle. A blow on the testicle is almost invariably attended with nausea and vomiting.

Vomiting is also frequently met with in irritation of the semilunar ganglia or infra-renal plexus, such as exists in

Addison's disease. It is also an early and prominent symptom of pulmonary phthisis.

The list given particularises the most common conditions of peripheral irritation which may set up vomiting. Of course cerebral disease, affecting the brain or its membranes, is to be regarded as a very constant cause of this condition. Romberg lays down the characters of *cerebral vomiting* as follows:—It is unattended with nausea or retching; it occurs when the head is moved, as in swinging, shaking, stooping, or suddenly rising; it occurs when the patient is erect rather than when he is recumbent; it is of a spewing character.

EXAMINATION OF VOMITED MATTERS.

The examination of vomited matters may be made simply with the naked eye, or, in certain circumstances, by the microscope. They may consist of the contents of the stomach, or of certain elements which enter it during the act of vomiting, as for instance bile. Ordinarily the contents of the stomach ejected consist of articles of food and drink, more or less altered by digestion and fermentation, saliva, epithelium, mucus, and traces of blood from the mouth, nose, and pharynx. In some cases, in addition to the substances mentioned, portions of foreign growths, fungi, such as torula and sarcinæ—worms, bile and pancreatic juice, pus, and fæcal matter, may be ejected.

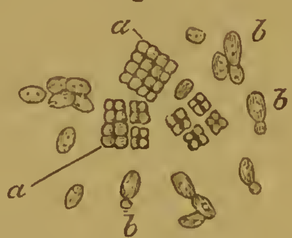
When vomiting takes place with an empty condition of the stomach, a ropy viscid mucus is brought up mingled with bile, which comes from the duodenum, and gives to the vomited matter a greenish hue. The act of vomiting is in such a case attended with severe and painful straining.

The most common abnormal element found in the vomited

matter is blood. If it be poured out rapidly from a large vessel, and quickly vomited, it may be unchanged in its physical characters. Usually it is retained for some time and blackened by the action on it of the hydrochloric acid of the gastric juice, when it resembles coffee-grounds. The two most common causes of hæmatemesis are gastric ulcer and portal obstruction. Hæmatemesis is also to be met with in certain fevers and blood diseases, yellow fever, purpura, and scurvy. It may result from injuries to the stomach, the bursting of an aneurysm into the organ, &c.

Other abnormal elements which are occasionally observed in the vomited matters are sarcinæ and some intestinal parasitic worms.

Fig. 48.



b, Yeast cells.
a, Sarcinæ ventriculi.

The chief clinical indications in connection with vomiting are as follows:—If the vomited food be unchanged, vomiting has occurred soon after the taking of a meal. This is usual in nervous vomiting and in disease affecting the cardiac orifice.

If there be disease of the pylorus, vomiting occurs a considerable time after the taking of food, which is more or less digested.

Very acid vomiting is common in chronic gastric catarrh; it is aggravated by the taking of saccharine articles of food, which help to produce acetic, lactic, and butyric acid fermentation.

Complete absence of hydrochloric acid in the vomited matter has been noticed in amyloid degeneration of the stomach, in acute anæmia, and in febrile conditions.

Sometimes large quantities of saliva are swallowed, especially during sleep, and vomited in the morning. This constitutes the matutinal or morning vomiting of drunkards.

Bile, more or less green and diluted, is vomited in affections of the liver, especially in acute or chronic congestion. Large quantities of bile mixed with the secretions from the mouth and stomach, and forming a grass-green liquid (*vomitus anginosus*), is met with in peritoneal and cerebral affections.

In dilatation of the stomach, especially when due to constrictive disease of the pylorus, large quantities of clear fluid are vomited, usually after a period of gastric toleration ending for ten days or a fortnight. For some time preceding the vomiting a feeling of gastric distress (*embarras gastrique*) is experienced, then several quarts of fluid are freely vomited. The surface of the vomited matter usually presents a barmy scum on the surface, in which sarcinæ are commonly found.

DEFÆCATION.

Normally the bowels are moved once in twenty-four hours, but it is not uncommon to find many healthy persons who have an alvine discharge but once in two or even more days, whilst others have in their usual condition of health a motion twice in each day. Ordinarily, from habit, the bowels are moved with a certain degree of periodicity, influeneed, however, materially by the quantity and quality of the food and drink taken, amount of exercise, &c.

During the act of defæcation various abnormal sensations may be experienced, such as faintness or sickness, painful

sense of straining, feeling as if the rectum was not emptied of its contents (tenesmus), sharp, burning pain and feeling of obstruction at the end of the bowel, &c. In such cases a careful examination for the existence of piles, prolapsus, ulcer, or fissure should be made.

The motions from the bowels may be insufficient and abnormally delayed. This constitutes *constipation;* or, they may be too frequent and liquid in consistence—*diarrhœa.*

Constipation most commonly arises from the following conditions:—

(*a*) Sluggish peristaltic action of the bowels arising from a number of conditions such as the use of bulky and indigestible food, deficiency of fluid ingested, sedentary habit of life, injudicious use of purgatives, deficient innervation, heredity, as a result of inflammation of the bowels or peritoneum, deficient secretion of bile, &c., &c.

(*b*) Mechanical obstruction such as would be produced by accumulations within the bowel, organic deposits, cicatricial contractions, strangulation, intussusception, spasm or paralysis.

(*c*) Deficiency of the intestinal secretions.

Diarrhœa usually arises from—

(*a*) Increased peristaltic action, owing to which the contents of the intestine are swept through it before the fluid constituents have undergone absorption, as in ulceration of the bowels, in certain nervous conditions, &c.

(*b*) Abnormally strong stimuli, which likewise cause increased peristalsis, the existence of irritating matter in the bowels, such as undigested food, hardened fæces, or noxious materials, and the use of drastic purgatives.

(*c*) Pathological conditions of various kinds affecting the mucous membranes of the intestines.

EXAMINATION OF THE FÆCES.

An examination of the fæces affords evidence as to the condition of the organs engaged in digestion, and data upon which to form a diagnosis. The examination, as in that of urine, deals with the physical characters of the discharges, as well as their microscopical and chemical constitution. As however, the general characters of the fæces must vary with the food taken, the examination of the bowel excreta does not afford so definite an indication of disease as that of the urine.

The physical characters deal with (*a*) quantity, (*b*) consistence and form, (*c*) colour, (*d*) odour, (*e*) reaction.

(*a*) The *quantity* varies with the quantity and nature of food taken and the activity of the secretions of the alimentary canal. It is increased by the use of a vegetable diet. It is comparatively large in children; small in old age. The average quantity excreted by a healthy adult is 5 ounces daily, varying from $2\frac{1}{2}$ to 10 ounces. In certain diseases attended with diarrhœa—acute catarrh, cholera Asiatica, cholera nostras or cholorine, dysentery, &c., the quantity may reach to several pounds in twenty-four hours, consisting mainly of watery transudation from the mucous surface.

(*b*) The *consistence* of the fæces depends upon the rapidity with which the intestinal contents pass through the bowels; the slower the rate the greater the absorption of fluid constituents, so that in constipation the discharges are solid, more or less dry and "formed" or "moulded." In infants the consistence of the fæces is that of pap. Where there is diarrhœa, the consistence varies between all degrees of fluidity. When there is great delay in the passage of the contents of the ileum into the large intestine, the motions become hard and nodular (scybala), and the hard masses may block up the

rectum and be expelled with extreme pain and difficulty. In some cases the existence of narrowing of the bowel, hæmorrhoids, rectal tumours, &c., may mould the fæces in various ways.

(*c*) The *colour* of the fæces is dependent mainly upon bile pigments and on the nature of the food taken. It is dark brown if the fæces are long retained, or in the case of an exclusively meat dietary; pale yellow with milk food; greenish if much vegetables be taken. In infants the motions are often observed to become greenish, especially if there be any gastro-intestinal derangement. The cause of this is not satisfactorily made out, though it may be attributed to some metamorphosis of bilirubin into biliverdin. A similar grass-green hue is observed after the administration of calomel (mercurous chloride).

The most important elements which affect the colour of the fæces are the following:—

Bile.—If there be obstruction to the passage of bile into the duodenum the motions are clay-coloured, or putty-like.

Blood.—Blood may simply streak the fæces, or it may be intimately mixed with them, so as to form a uniform brick-red or blackish colour, the black colour being produced by the action of sulphuretted hydrogen forming a black sulphide of the iron existing in the blood. If the blood be poured out into the stomach the action of the gastric juice converts it into a tarry-looking material of characteristic appearance (Melæna).

Diet.—Certain articles of food give to the fæces a characteristic colour—such as spinach, coffee, claret, and porter. Drugs, too, have the effect of altering their appearance. Logwood and charcoal may be unaltered

in the stools. Iron and bismuth render the motions black or olive green.

(*d*) *Odour*.—The odour is characteristic and depends mainly upon volatile products which are developed from the decomposition of fatty matters in connection with pancreatic digestion, partly upon special secretions from the glands of the colon, and partly upon the use of certain articles of food or medicine. The simpler and plainer the food taken, the less disagreeable the smell; so, too, when the motions are very fluid and succeed each other at short intervals there is almost an absence of odour, as in cholera.

Where the bile is absent, and pancreatic digestion is interfered with, an extremely fœtid odour of a putrescent character is observed. The same condition is observed in epidemic dysentery.

(*e*) The *reaction* of fæces is usually acid. It is always alkaline in enteric fever. In acute catarrhal enteritis of children it is highly acid; also whenever the strongly alkaline secretions of the liver and pancreas are prevented from entering the canal.

The following abnormal substances may be found in fæces:

Foreign bodies, such as coins, pins, pieces of slate pencil, &c.

Indigestible food, such as fish bones, cherry-stones, &c.

Undigested food, such as pieces of gristle, skins of fruit, bulky vegetables, &c. Sometimes the food passes unchanged a short time after it has been taken—lienteric diarrhœa.

Fatty substances, such as may follow the administration of oils—castor oil, cod-liver oil, &c.; curdy lumps from imperfect digestion of milk, as in children; in discharges which occur when the biliary and pancreatic secretions are deficient.

Entozoa, such as segments of tænia, the various round worms, hydatids, &c.

Gall-stones, intestinal concretions (intestinal calculi), *casts of intestinal sloughs, pus, &c.*

The microscopical examination of the fæces is made by shaking up a portion of the evacuations several times with two or three times their bulk of distilled water, and allowing the mixture to stand for a time. The ordinary microscopic constituents are undigested and indigestible residues of the food, epithelium, oil, crystals of triple phosphates, and amorphous granular matter.

Chemical Examination.—This reveals that the fæces contain, on an average, about 23 per cent. of solid matter, but this proportion is greatly lessened in disease, especially where the stools are of a fluid consistence.

The solids found are as follows:—

Excretin and Stercorin.—These are bodies closely related to cholesterin, and are regarded as characteristic of fæces. About ten grains of stercorin and two of excretin represent the average amount found per diem (Flint).

Fatty Acids and Soap.—Excretolic acid and free stearic and inorganic acids, in minute quantities, are constant ingredients; also the soda and potash soaps.

Salts.—These form but a small amount and are chiefly represented by the earthy and triple phosphates, small quantities of iron and silica, with a marked absence of chlorides.

Pigment.—The pigments found in fæces are derived from the bile.

Mucus and Albumen.—A small amount of mucus is passed normally with the fæces; it is largely increased in

several diseased conditions. Ordinarily, albumen is not an ingredient of fæces, but it is present in large quantities in cholera stools, which resemble blood serum in composition.

The clinical indications derived from an examination of the stools may be tabulated under the heads of Cholera, Dysentery, Enteric Fever, Pancreatic Disease, Hepatic Disease, and Fever.

Cholera.—The stools in the algid stage of cholera are rice-water or whey-like in appearance, inodorous, excreted in from 50 to 100 ounces or more in twenty-four hours, and wholly wanting in bile pigment. They are composed of a *fluid* which is alkaline and contains a large proportion of chloride of sodium and some albumen, and a sediment in which are found whitish flocculi consisting of epithelium, fungi, granular *débris*, and crystals of salts—chiefly phosphates. In most, if not all, cases of Asiatic cholera, a peculiar curved bacillus or spirillum, known as Koch's "comma bacillus," is found in the intestinal discharges. In cholera nostras, or cholorine, a micro-organism resembling Koch's has also been found.

Dysentery.—Stools fœtid or gangrenous in odour, like that of a dissecting room. A great number of discharges, sometimes amounting to hundreds, in twenty-four hours, only a few drachms being voided at a time. Sometimes the discharges represent yellowish masses of mucus speckled with blood and mixed with a small quantity of fæcal matter; in the late stages small red lumps, like raw washed meat, are observed in a reddish albuminous fluid. At other times the stools may consist of blood, pus, or gangrenous shreds of the bowel, which are expelled with a brownish serous fluid.

Enteric Fever.—The usual stools in this disease are of a pale brownish-yellow liquid, resembling pea-soup, alkaline in

reaction, and very offensive in odour. The fluid has a sp. gr. of 1015 and contains 4 per cent. of solids, chiefly albumen and chloride of sodium. Blood is often present in the discharges.

Mistakes often arise from supposing that these characters of stool are peculiar to enteric fever; they are met with in ulcerations of the bowels of a tubercular nature, and in some cases of intestinal catarrh.

Pancreatic Disease.—Where from disease the pancreatic juice does not pass into the intestine the stools are found to contain fat in variable quantity, sometimes in the form of loose drops or lumps, sometimes smeared over the fæces, or discharged unmixed, constituting what is termed stearrhœa. This has been the teaching of Bright. Cases have, however, been recorded where, with obstruction of the pancreatic duct, fat has not been found in the stools, so that the existence of fatty stools cannot be taken as pathognomonic of pancreatic disease.

In cases where the bile is completely excluded from the intestines the evacuations are found to contain fat in large quantities if that substance be taken with the food.

Hepatic Disease.—The stools, where there is obstruction to the passage of bile from the liver, are usually white or *clay*-coloured, unformed, and of porridge-like consistence, and of very offensive odour. Sometimes they contain fat.

Fevers.—In fevers generally the fæces are small in quantity, dark-brown in colour, usually dry in consistence, and offensive in odour.

APPENDIX.

CASE-TAKING.

The following method of Case-Taking may assist the Student in noting the important points in connection with various Medical diseases :—

Name of Patient.—Age.—Occupation.—Residence.—Date of Admission to Hospital.

Prominent Symptoms complained of, or **Complaint** itself, and its **Duration.**

History.—*Personal*—Habits as to food and drink; exposure to wet and cold; general conditions as regards home and place of work; scrofula; syphilis; previous illness; mode of origin of present illness.

Family History.—Parents—if living, ages and condition of health of; if dead, age at time of death, and cause of death. Brothers and Sisters—ages and state of health of those living; of those dead, ages at time of death, and cause of death. Liability to nervous affections, such as convulsions, epilepsy, or insanity. Hereditary history of cancer, syphilis, scrofula or tuberculosis, rheumatism or gout.

State on Admission.—*General Appearance*—Well-nourished or emaciated; anæmic or florid; height; weight; prominent morbid appearances—such as dropsy, cyanosis, jaundice, bronzing, &c.; presence or absence of pain; condition of skin and temperature; decubitus.

Systems chiefly affected to be specially investigated as follows:—

Respiratory System.—*Symptoms* complained of—Cough; pain; dyspnœa. *Breathing*—Its frequency, rhythm, type. *Sputa*—General characters of. *Inspection*—Shape of thorax; movements of chest during respiration. *Palpation*—Vocal fremitus. *Percussion*—Difference over corresponding regions of chest; sense of resistance. *Auscultation*—Alteration of breath sounds; adventitious sounds; vocal resonance.

Circulatory System.—*Symptoms* complained of—Pain; palpitation; dyspnœa. *Inspection*—Shape of præcordia; situation of impulse beat. *Palpation*—Site and character of impulse beat; thrill. *Percussion*—Absolute and relative dulness. *Auscultation*—Character of sounds; the rhythm and seat of maximal intensity of murmurs. *Pulse*—Frequency, quickness, volume. Condition of arteries, veins, and capillaries.

Digestive System.—Appetite; thirst; nausea; vomiting; pain; flatulency; acidity; eructations; heartburn; weight or uneasiness after the taking of food; condition of tongue, lips, teeth and gums; characters of vomited matters; state of bowels and characters of the alvine discharge. ABDOMEN.—*Inspection*—Prominence, retraction. *Palpation*—Tenderness; fulness; position and dimensions of different organs; sense of fluctuation. *Percussion*—Extent and outline of various organs; tympanicity or dulness.

Integumentary System.—*Symptoms*—Dryness or moisture; irritation, itching, or pain; obesity or emaciation; œdema; emphysema; cyanosis; pigmentation; various forms of skin disease.

Hæmatopoietic System.—Condition of blood-making glands—lymphatic glands, spleen, thyroid body; evidences of anæmia or plethora; microscopic examination of blood.

Genito-Urinary System.—*Symptoms*—Pain or irritation in the loins, bladder, or urethra; increased frequency of micturition; ardor urinæ. *Urine*—Its sp. gr., reaction, colour, quantity; presence of albumen, sugar, or bile; deposits—macroscopic and microscopic appearances. MALE—Subjective phenomena; virile power; conditions affecting the testicle, epididymis, prostate, urethra. FEMALE—Subjective phenomena; menstruation, all abnormalities in connection therewith; leucorrhœa; examination—digital, with speculum or with sound; conditions affecting the ovaries.

Nervous System.—*Sensory System*—Different forms of sensibility, muscular sense, special senses; pain; hyperæsthenia; analgesia; numbness; formication, tingling; superficial, deep, and visceral reflexes; alteration as regards vision (ophthalmoscopic examination), hearing, taste, and smell. *Motor System*—Paralysis, distribution and degree of; tremors, convulsions, spasm, and cramps; condition of muscles in different forms of rigidity; faradaic and voltaic irritability; reaction of degeneration; functions of the bladder and rectum. *Vaso-Motor and Trophic System*—Alterations of temperature; local sweating; bed-sores (acute and chronic decubitus); œdema; glossy skin; wasting; growth of hair; arthritic lesions. *Psychical Disturbances*, as shown by emotional tendencies; defects of intelligence, memory, and speech; illusions and delusions; forms of insanity; stupor and coma.

Diagnosis.

Prognosis.

Treatment—Dietetic, Medicinal, and General.

Progress of the Case.

GLOSSARY.

Abdōmen, inis, n. (*abdo*, to hide, or perhaps for *adipomen*, from *adeps*, fat). *The largest cavity of the human body ; the belly.*

Abnormal (*ab*, from, *norma*, a square, or rule). *Contrary to the rule of nature ; irregular.*

Abortus (*aborior*, to miscarry). *Abortion.*

Abscess (*abscēdo*, to depart). *A tumour, the parts or walls of which are separated by matter or pus.*

Acephalocystis (*α*, *privativum* [expressing *want* or *absence of*, like Lat. *in-*, Eng. *un-*], κεφαλή, a head, κύστις, a bladder). *Hydatid.*

Ache (ἄχος, affliction). *A continued throbbing pain.*

Acoustic (ἀκούω, to hear). *Of or belonging to hearing.*

Acute (*ăcŭo*, to point). *Sharp and pungent ; applied to diseases which have violent symptoms.*

Adenoid (ἀδήν, a gland ; εἶδος, appearance, look, resemblance). *Like a gland ; glandular.*

Adeps, ĭpis, m. and f. (from Gk. ἄλειφαρ, *anointing oil*, with interchange of *d* and *l*). *Fat* (*the product of good living*).

Adynamia, æ, f. (*α*, *priv.*, and δύναμις, power). *A term for loss of vital power or strength.*

Ægophony (αἴξ, *g.* αἰγός, a goat, φωνή, voice). *Shrill, trembling voice*, like the bleating of a goat.

Aidoici (αἰδοῖα, pudenda) [sci. morbi]. *Diseases of the generative organs.*

Albuminuria (*albūmen*, white of egg, and οὖρον, urine). *Presence of albumen or white of egg in urine.*

Alcoholismus, i, m. *Alcoholism.*

Algĭdus, a, um. *Cold.*

Alveoli (*alveus*, a cavity). *The air vesicles in the lungs.*

Amenorrhœa (*α*, *priv.*, μήν, month, ῥοή, a river, or flowing, from ῥέω, to flow). *Absent or defective menstruation.*

Amphoric (ἀμφορεύς, a jar). *Jar-like.*

Amy̆lum (ἄμυλον, fine meal, *i.e.*, not ground at the mill, from *α*, *priv.*, and μύλη a mill). *Starch.*

Anasarca (ἀνα, through, σάρξ, flesh). *Dropsy of the cellular tissue throughout the body.*

Anæmia (*α*, *priv.*, αἷμα, blood). *Bloodlessness.*

Anæsthesia (α, *priv.*, αἰσθάνομαι, to perceive). *Loss of sensation.*

Aneurysma, atis, n. (ἀνεύρυσμα, from ἀνευρύνω, to dilate, ἀνά, upon [intensive], εὐρύς, wide). *Aneurysm.*

Angīna (ἄγχω, angĕre, to choke). *Painful choking sensation.* [For the short quantity, compare the Gk. ἀγχόνη, a throttling, or strangling.]

Angīna pectŏris. *Painful spasms of chest, with a sense of impending death.*

Anhidrōsis (ἀνίδρως, without perspiration, from ἀν-, priv., ἱδρώς, sweat). *Deficiency, or absence, of perspiration.*

Anorexia (α, *priv.*, ὄρεξις, desire). *Loss of appetite.*

Anthrax, acis, m. (ἄνθραξ, a coal). *A carbuncle.*

Aortitis (ἀορτή, the great artery, from ἀείρω, to lift, heave, raise up). *Inflammation of the aorta.*

Aphonia (α, *priv.*, and φωνή, the voice). *Loss of voice.*

Apoplexia (ἀποπλήσσομαι, to lose one's senses). *Apoplexy.*

Aphtha (ἅπτω, to inflame). *The thrush; curd-like deposits on the mucous membrane of the mouth.*

Argyria (ἄργυρος, white metal, *i.e.*, silver, from ἀργός, shining, glistening, bright). *Discoloration of the skin, mucous membranes, and tissues with silver salts.*

Arteria (αἴρω, to carry). *Artery.*

Arteritis. *Inflammation of an artery.*

Arthritis (ἄρθρον, a joint). *Inflammation of the joints.*

Ascaris lumbricoides (ἀσκαρίζω, to leap). *Round worm.*

Ascaris vermicularis. *Thread worm.*

Ascites (ἀσκόν, a bladder). *Dropsy of the belly.*

Asphyxia (α, *priv.*, σφύξις, pulse). *Pulselessness, suspended animation from n n-arterialisation of the blood.*

Asthenia (α, *priv.*, σθένος, strength). *Want of strength.*

Asthma (ἆσθμα, laborious breathing). *A peculiar spasmodic disease of the bronchi.*

Ataxic fever (ἀταξία, a being ἄτακτος, *i.e.*, out of order, or battle array, from α, *priv.*, τάσσω, to arrange, put in order or battle array). *Fever with marked nervous or cerebral symptoms.*

Atelectasis (ἀτελής, imperfect, ἐκτείνω, to stretch out). *Imperfect distension with air of the lung substance in new-born children.*

Atheroma (ἀθήρη = ἀθάρη, groats or meal). *Fatty degeneration of the coats of arteries, from inflammation.*

Atrophy (ἀτροφία, atrophy, α, *priv.*, and τροφή, food). *A wasting of the whole or portion of the body.*

Auscultation (*ausculto*, to listen). *The act of listening to the sounds or movements of the heart and lungs.*

Bacillus (Lat. *bacillum* or *bacillus*, a little stick). *A rod-shaped micro-organism, species of which are found in such diseases as splenic fever, leprosy, tuberculosis, and ague.*

Bacterium (βακτήριον, dim. of βάκτρον, a staff or cane). *A micro-organism consisting of short cylindrical cells, isolated, or in small heaps loosely united, or in irregular gelatinous families (Zooglœa).*

Balneum, i, n. *Bath.*

Balneum calĭdum. *Warm bath.*

Balneum frigĭdum. *Cold bath.*

Balneum marīnum. *Sea-water bath.*

Balneum tepĭdum. *Tepid bath.*

Balneum vapōris. *Vapour bath.*

Barometer (βάρος, weight, μέτρον, measure). *An instrument for determining the weight of the atmosphere.*

Bilious (*biliosus*, full of bile, from *bilis*, bile). *Having much bile.*

Biology (βίος, life, λόγος, a discourse). *A term for the doctrine of life.*

Bronchiectasis (βρόγχια, the bronchial tubes, ἐκτείνω, to extend). *Dilatation of the bronchi.*

Bronchitis. *Inflammation of the bronchi.*

Bronchophony (βρόγχος, a windpipe, φωνή, voice). *Voice heard through solid lung.*

Bronchocele (βρόγχος, a windpipe, κήλη, tumour). *Tumour of thyroid gland.*

Bruit (Fr.) *A noise.*

Bruit de cuir neuf. *New leather creak.*

Bruit de diable. *Humming sound.* [Germ. *Nonnengeräusch.*]

Bruit de lyre. *Lyre sound.*

Bruit de pot fêlé. *Cracked pot sound.*

Bruit de râpe. *Rasping sound.*

Bruit de roucoulement. *Cooing sound.*

Bruit de scie. *Sawing sound.*

Bruit de soufflet. *Bellows sound.*

Bullæ. *Blebs.*

Bulīmia (βουλιμία, ravenous hunger, from βου, intensive, or βοῦς, ox, λιμός hunger). *Excessive appetite*, as of diabetes mellitus.

Butȳrum (βοῦς, cow, τυρός, cheese). *Butter.* [Hence *Butyric acid.*]

Cachectici (καχεξία, bad habit of body) [sci. morbi]. *Cachectic diseases.*

Calculus, i, m. *Stone.*

Calor, ōris, m. *Heat.*

Calor mordax. *Biting heat.*

Cancer, cri, m (a crab). *Cancer.*

Cardiaci (καρδία, heart) [sci. morbi]. *Heart diseases.*

Cardialgia (καρδία, the heart, ἄλγος, pain). *Heartburn, pain referred to region of the heart.*

Carditis (καρδία, heart). *Inflammation of the heart.*

Carcinoma (καρκίνος, an eating ulcer). *Cancer.*

Cardiograph (κάρδια, the heart, γράφω, to write). *An instrument which registers in curves the systole and diastole of the heart's chambers.*

Caries, f. (dry decay). *Destructive process in bones.*

Caro, carnis, f. *Flesh.*

Carphology (καρφολογία, a gathering of chips or bits of wool, from κάρφος, *palea*, and λέγω, to gather). *Same as* "Floccitatio," *which see.*

Caseation (*casĕus*, or *casĕum*, cheese). *A pathological change in inflammatory products which become yellow, friable, and dry.*

Catamenia (καταμήνιος, monthly). *The menses.*

Causa continuens. *The proximate cause.*

Causa excitans. *The exciting cause.*

Catarrh (καταῤῥέω, to flow down). *Inflammation of, and discharge of mucus from a mucous membrane.*

Cephalici (κεφαλή, head) [sci. morbi]. *Brain diseases.*

Cerevisia, æ, f. (*Ceres*, the goddess of agriculture, corn). *Any liquor brewed from corn.*

Cheloid (χηλή, a crab's claw). *A skin disease first described by Alibert under the name Cancroïde. See* Keloid.

Chloasma (χλόη, light green). *A synonym for Pityriasis versicolor of Willan* (which see).

Chlorosis (χλωρός, pale green). *Green sickness, a form of anæmia.*

Cholera nostras (χολή, bile). *English or bilious cholera.*

Cholera Asiatica. *Asiatic or true cholera.*

Cholerine = Cholera nostras.

Chololithus (χολή, bile, λίθος, stone). *Chololith, a gall-stone, a biliary calculus.*

Chorēa (χορός, a dance, χορεία, a dancing). *Chorea, St. Vitus's dance.*

Chrotici (χρώς, skin) [sci. morbi]. *Skin diseases.*

Chyluria (χυλός, juice, chyle, οὖρον, urine). *An affection characterised by milky-looking urine from presence of chyle or lymph in cases of lymphatic obstruction.*

Cicātrix, īcis, f. *A scar.*

Cirrhosis (κίῤῥος, yellow). *A contractile disease of organs* [a term originally applied to the liver stained with retained bile].

Climacterium (κλιμακτήρ, the round of a ladder). *Turn of life.*

Clinical (κλίνη, a bed). *At the bedside.*

Clonic (κλόνος, a violent tumult or motion). *A form of spasm or convulsion in which contraction and relaxations alternate.*

Clyster (κλυστήρ, an injection, from κλύζω, to wash [Lat. *cluĕre*=*purgāre*]). *An enema, or injection.*

Cochleāre, āris, n. (*cochlea*, a snail's shell). *Spoon.*

Cochleare amplum. *Table-spoon.*

Cochleare medium. *Dessert-spoon.*

Cochleare parvum (v. infantis). *Tea-spoon (infant's).*

Coma (κῶμα, deep sleep, or slumber). *Stupor with loss of sensation and volition.*

Constipatio (a crowding together). *Constipation, confinement of the bowels.*

Convulsio. *Cramp,* or *convulsion.*

Cor, cordis, n. (κέαρ, κῆρ). *The heart.*

Coryza (κόρυζα, cf. Lat. *pituita,* from κόρυς, a helmet, the head). *A catarrh of the mucous membrane of the nose.*

Costiveness. *Abnormal dryness and hardness of the fæces, causing constipation.*

Creatinin (*or* Kreatinin) (κρέας, raw flesh). *A constituent of urine forming glistening, colourless, oblique prisms, increased in fevers, diminished in anæmia, diabetes, Bright's disease, and tetanus.*

Cretinismus (Fr. *crétin*). *Cretinism, idiotcy with deformity.*

Crepĭtus, i, m. *A crackling sound.*

Crisis (κρίσις, decision). *The event or issue of an illness.*

Cucurbĭtŭla. *Cupping-glass* (Celsius).

Cucurbitulæ cruentæ. *Wet cupping.*

Cucurbitulæ sine ferro. *Dry cupping.*

Cyanosis (κύανος, a dark blue substance). *Blue discoloration, from congenital imperfections of the heart or defective oxygenation of the blood.*

Cyathus (κύαθος, a cup). *Wine-glass.*

Cynanche (κύων, a dog, and ἄγχω, to strangle, because dogs were supposed to be specially subject to choking sensations). *Term for inflammation of the throat.*

Cynanche Parotidea (παρά, beside, and οὖς, the ear). *Mumps.*

Cyrtometer (κυρτός, curved, μέτρον, a measure). *An instrument for measuring the shape of the chest.*

Cystin (κύστις, the bladder). *The chief constituent of certain calculi found in the human bladder. It is also present in disease in the kidney, liver, and sweat.*

Cystitis (κύστις, a bladder). *Inflammation of the bladder.*

Debility (*debilitas,* lameness, weakness) [from *debilis*]. *Weakness.*

Decubĭtus (*decumbĕre,* to lie down). *Position of lying down.*

Delirium, ii, n. (*delīro,* to go out of the furrow, to rave). *Delirium.*

Delirium tremens (*tremo,* to tremble). *Madness of drunkards; the trembling delirium.*

Dementia (*de,* without, *mens,* mind). *Loss of reason.*

Dentitio (*dens,* a tooth). *Teething.*

Dermatophyta (δέρμα, skin, φυτόν, a plant). *A class of skin diseases.*

Desquamation (*desquāmo,* to scale fishes). *Term for separation of laminæ of bones or skin.*

Diabētes (διαβήτης, a siphon, from δία, through, βαίνω, to go). *Excessive flow of urine.*

Diabetes mellītus (Lat. *mel*, honey). *Same, with sugar in urine.*

Diagnosis (διάγνωσις, a distinguishing, from δία, through, γιγνώσκω, to know). *The discrimination of diseases.*

Diagnosticate (ἡ διαγνωστική [sci. τέχνη], the art of distinguishing diseases). *To arrive at an opinion as to the nature of a disease.*

Diaphoresis (διαφόρησις [Galen], from διαφόρεω, to carry away, or off). *Sweating.*

Diaphragm (διάφραγμα, a partition wall, a barrier; from διαφράγνυμι, to barricade). *The midriff.*

Diarrhœa (διαῤῥοή, a flowing through, from δία, through, ῥοή, a river, flux, from ῥέω, to flow). *Looseness of the bowels.*

Diastole (διαστολή, a drawing asunder, from διά, through, στέλλω, to set or send). *The dilatation of a contractile cavity, such as the chambers of the heart. See* Systole.

Diathetici (διάθεσις, condition) [sci. morbi]. *Diathetic diseases; also, Constitutional diseases.*

Dietici (δίαιτα, way of life) [sci. morbi]. *Diseases depending on unwholesome modes of living; Dietic diseases.*

Diphtheria (διφθέρα, a prepared hide). *An infectious disease affecting the fauces, on which a false membrane is deposited.*

Diuresis (διουρέω, to pass water). *Excessive flow of urine.*

Diuretics (διουρητικός, promoting urine). *Medicines taken internally to increase the secretion of the kidneys.*

Drachma, æ, f. (δραχμή, an Attic weight = 66·5 grains). *Drachm, or sixty grains.*

Dysentery (δυσεντερία, from δύς, difficult, ἔντερον, intestine). *Dysentery, inflammation of the colon.*

Dysenteria pustulosa. *Pustular dysentery, inflammation of follicles of colon.*

Dysmenorrhœa (δύς, difficult, μήν, month, ῥοή, flux, from ῥέω, to flow). *Difficult or painful menstruation.*

Dyspepsia (δυσπεπτέω, to digest with difficulty, from δύς, difficult, πέπτω, to digest). *Difficult digestion.*

Dyspnœa (δύσπνοια, from δύς, difficult, πνοή, breath). *Difficulty of breathing.*

Ecchymosis (ἐκχύμωσις, from ἐκχυμόομαι, to shed the blood from the small vessels). *A blue or black stain from extravasation of blood into the areolar tissue.*

Echīnococci (ἐχῖνος, hedgehog, and κόκκος, a kernel). *Immature tape worms found in hydatid cysts.*

Eclampsia (ἐκλάμπω, to shine forth). *Epileptiform convulsions.*

Ecthȳma (ἔκθυμα, from ἐκθύω, to break out). *A pustular disease of the skin.*

Eczĕma (ἔκζεμα, from ἐκζέω, to boil up). *A vesicular eruption.*

Elephantiasis (ἐλεφαντίασις, from ἐλέφας, an elephant) Arabum, Græcorum. *Leprosy.*

Embolism (ἔμβολος, or ἔμβολον, a wedge or plug). *The obstruction of a blood-vessel by a fibrinous concretion detached from the heart or one of the vessels.*

Embryo (ἔμβρυον, from ἐν, in, βρύω, to swell, or teem with). *The germ.*

Emphysema (ἐμφύσημα, from ἐμφυσάομαι, to be inflated). *Distended state of the pulmonary air-cells; also of areolar tissues, with air.*

Endemic (ἔνδημος, at home, from ἐν, amongst, and δῆμος, the people). *Referring to diseases constantly prevailing in certain localities*, such as cholera in India.

Emplastrum, i. n. (ἐμπλαστός, daubed on, from ἐμπλάσσω, to plaster up). *A plaster.*

Emplastrum calefaciens. *A warming plaster.*

Emplastrum lyttæ. *A blister.*

Emplastrum robŏrans (rōbŏro, to strengthen. *A strengthening plaster.*

Emplastrum vesicatorium. *A blister.*

Empyema (ἔμπυημα, a gathering, from ἐν, in, πύον, pus). *Pus in the pleural cavity.*

Encephalitis (ἐγκέφαλος, within the head, from ἐν, in, κεφαλή, head). *Inflammation of the brain, &c.*

Encephaloïdes (ἐγκέφαλος, brain, εἶδος, like). *Brain-like cancer.*

Endocarditis (ἔνδον, within, κάρδια, heart. *Inflammation of the lining membrane of the heart.*

Enĕma, tis, n. (ἔνεμα, an injection or clyster, ἐν, in, ἵημι, to send). *An injection.*

Enema catharticum. *Purgative injection.*

Enema fœtidum. *Fœtid injection.*

Enema terebinthĭnæ. *Turpentine injection.*

Enema tabāci. *Tobacco injection.*

Enterici (ἔντερον, intestine) [sci. morbi]. *Bowel diseases.*

Enteritis (ἔντερον, intestine). *Inflammation of the intestines.*

Epidemic (ἐπιδήμιος, among the people, from ἐπί, upon, δῆμος, the people). *Referring to diseases which attack a number of people simultaneously.*

Epigastrium (ἐπιγάστριος, over the belly, from ἐπί, upon, γαστήρ, the belly). *The epigastric region of the abdomen.*

Epilepsia (ἐπίληψις, a taking hold of, seizure, from ἐπιλαμβάνω, to seize upon). *Epilepsy.*

Ephelides (ἐφηλίδες, from ἐπί, on, ἥλιος, the sun; or better, ἧλος, a nail, head, or stud). *Freckles* [which *stud* the face], *liver spots.*

Epithelium, i, n. (ἐπί, on, θηλή, a nipple). *The cuticle covering any dermic surface, whether skin or mucous membrane.*

Epithelioma. *Epithelial tumour.*

Equinia (L. *equus*, a horse). *The glanders.*

Erysipelas (ἐρυσίπελας, from the same root as ἐρυθρός, red, πέλλα, skin). *St. Anthony's fire, the Rose, Erysipelas.*

Erythēma (ἐρύθημα, from ἐρυθαίνω, to make to blush). *Erythema, an inflammatory redness of the skin.*

Etiology [more correctly "Ætiology"] (αἴτια, cause, λόγος, discourse). *An account of the causes of disease.*

Exanthēmata (ἐξάνθημα, an efflorescence or eruption, from ἐξανθέω, to put forth flowers [ἐκ, out of, ἄνθος, a flower]). *Rashes, and particularly fevers accompanied by skin rashes.*

Exophthalmic goître (ἐξόφθαλμος, with prominent eyes, from ἐκ, out of, ὀφθαλμός, the eye). *Protrusion of the eyes with goître.* Graves' Disease ; Basedow's disease.

Exostosis (ἐξόστωσις, from ἐκ, out of, ὀστέον, bone). *Tumour on bone.*

Fatuitas. *Idiotcy.*

Febris, is, f. (for *ferbris*, from *fervēre*, to be warm). *Fever.*

Febris a fame. *Famine fever.*

Febris continua. *Continued fever.*

Febris ephemeralis (ἐφήμερος, ἐπί, upon ἡμέρα, a day). *One day fever.*

Febris gastrica. *Fever with gastric symptoms.*

Febris intermittens. *Intermittent fever*, viz.—

,, quotidiana. *Quotidian, or with daily exacerbations.*

,, tertiana. *Tertian, every third day* (counting inclusively) *exacerbations.*

,, quartana. *Quartan, every fourth day* (counting inclusively) *exacerbations.*

Febris maculata *vel* maculosa (Lat. *macula*, a spot). *Maculated fever.*

Febris miliaris (*milium*, a millet seed). *Miliary or sweating fever.*

Febris petechialis. *Petechial, or maculated, or spotted fever. Typhus. See* Petechiæ.

Febris primaria. *Primary fever.*

Febris puerperarum (*puer*, a child, *pario*, to bring forth). *Fever of lying-in women.*

Febris recurrens. *Relapsing fever.*

Febris remittens. *Remittent fever.*

Febris rheumatica. *Rheumatic fever, or acute rheumatic arthritis.*

Febris synŏcha. *Inflammatory fever. See* Synocha.

Febris typhoides (typhus + εἶδος, form, likeness). *Typhoid or enteric fever.*

Febris typhosa (τῦφος, smoke, vapour, stupor). *Spotted fever with cerebral symptoms. Typhus.*

Febris typhosa icterodes (ἰκτερώδης, jaundiced). *Yellow fever.*

Fistula (*fistula*, a pipe). *Term for a sinuous ulcer or canal secreting matter.*

Floccitatio, onis, f. (*floccus*, the flock of wool). *Picking of the bed-clothes. See* Carphology.

Fomĭtes (pl. of *fomes*, touchwood, fuel). *Porous substances which absorb and retain contagious effluvia.*

Fragilitas ossium (*frangĕre*, to break). *Brittleness of the bones.*

Frambœsia (Fr. *framboise*, a raspberry). *The yaws.*

Frémissement cataire (Fr., Laennec). *Purring tremor*, like that of a cat, felt over the heart in some cases of valvular disease.

Fremitus, ûs. *Murmuring noise, accompanied by thrill.*

Frottement (Fr.). *The thrill of rubbing or friction.*

Fungus hæmatodes (αἱματώδης, looking like blood, from αἷμα, blood, εἶδος, likeness). *Bleeding cancer.*

Furfur, ŭris. *Bran, scurf.*

Furuncŭlus, i. m. (dim. *a petty thief*, from *furax*, inclined to steal, thievish). *A boil.*

Gangræna (γάγγραινα, from γράω, to gnaw). *Gangrene, mortification.*

Gangræna nosocomialis (*see* Nosocomium). *Hospital gangrene.*

Gangræna senilis. *Dry gangrene.*

Gargouillement (Fr.) *Gurgling sound.*

Gastralgia (γαστήρ, stomach, ἄλγος, pain). *Pain in the stomach, especially of neuralgic origin.*

Gastritis (γαστήρ, the stomach). *Inflammation of the stomach.*

Geratici (γῆρας, old age) [sci. morbi]. *Diseases of old people.*

Glossitis (γλῶσσα, the tongue). *Inflammation of the tongue.*

Glottis (γλωττίς). *Mouth of the windpipe.*

Glycosuria (γλυκύς, sweet, and οὖρον, urine). *Sugar in the urine.*

Goitre (Fr. *goître*, from Lat. *guttur*, the throat). *Hypertrophy of the thyroid gland.*

Gonorrhœa (γονόῤῥοια, γονή, semen, ῥοή, a flux, from ῥέω, to flow). *Specific urethritis, with purulent discharge from the urethra.*

Granum, i. n. *A grain.*

Gyniaci [more correctly *Gynœcii*], (γυναικεῖος, of or belonging to women, from γυνή, *g.* γυναίκος, woman) [sci. morbi]. *Diseases of women.*

Hæmatemesis (αἷμα, *g.* αἵματος, blood, ἔμεσις, vomiting). *Vomiting of blood.*

Hæmatinuria (*hœmatin*, the colouring matter of the blood, and οὖρον, urine) *Urine containing merely the colouring matter of the blood.*

Hæmatogenous (αἷμα, αἵματος, blood, γένος, offspring). *Term applied to jaundice and to albuminuria having their origin in blood changes, blood-derived.*

Hæmaturia (αἷμα, blood, οὖρον, urine). *Bloody urine.*

Hæmoptysis (αἷμα, blood, πτύω, I spit). *Spitting of blood.*

Hæmorrhage (αἱμοῤῥαγία, a violent bleeding, from αἷμα, blood, ῥήγνυμι, to break forth). *Bleeding.*

Haustus, ûs, m. *Draught.*

Hepatisation (ἡπατίζω, to be like the liver, from ἧπαρ, the liver). *A term applied to the condition of the lungs in the second stage of acute croupous pneumonia.*

Hepatitis (ἧπαρ, *g.* ἥπατος, the liver). *Inflammation of the liver.*

Hepatogenous (ἧπαρ, ἥπατος, liver, γένος, offspring). *Term applied to jaundice arising from the absorption of bile already formed in the liver. Obstructive jaundice.*

Hernia (ἕρνος, a sprout). *A rupture.*

Herpes (ἕρπης, ἕρπητος, from ἕρπω, to creep). *A vesicular eruption.*

Hirūdo, ĭnis, f. *Leech.*

Hyaline (ὕαλος, any clear transparent stone, glass). *A transparent colourless substance.*

Hydatid (ὑδατίς, g. ὑδατίδος, a drop of water). *A parasite resembling a sac of water.*

Hydræmia (ὕδωρ, water, αἷμα, blood). *A watery condition of the blood.*

Hydrocele (ὑδροκήλη, water in the scrotum, from ὕδωρ, water, κήλη, a tumour). *A tumour with effusion, connected with the testicle, spermatic cord, or [in the female] the canal of Nuck.*

Hydrocephalus (ὑδροκέφαλον, from ὕδωρ, water, κεφαλή, head). *Hydrocephalus, water on the brain.*

Hydrophobia (ὑδροφοβία, from ὕδωρ, water, φόβος, fear). *Rabies* from the bite of a mad animal.

Hydrops (ὕδρωψ, from ὕδωρ, water). *Dropsy.*

Hydrothorax (ὕδωρ, water, θώραξ, chest). *Water on the chest: dropsy of the pleura.*

Hyperplasia (ὑπέρ, over, πλάσσω, to form). *Numerical hypertrophy, or increase in the number of cellular elements of a part.*

Hypertrophy (ὑπέρ, over, τρέφω, to nourish). *Excessive increase in size of a part from increase in the size of its essential elements.*

Hysteria (ὑστέρα, the womb). *A functional disorder of the nervous system.*

Hysteritis. *Inflammation of the womb.*

Icterus (ἴκτερος, a yellow bird). *Jaundice.*

Ichthyōsis (ἰχθύς, a fish). *A scaly skin disease.*

Idiopathic (ἰδιοπαθής, affected for oneself, or in a peculiar way, from ἴδιος, peculiar, separate, πάθος, suffering). *A spontaneous or primary disease.*

Ileus (εἰλέω, to twist). *Ileus*, passio iliaca, *painful twisting of the guts.*

Impetīgo (*impĕto*, to invade). *A scabby and pustular disease of the skin.*

Index, ĭcis. *A pointer, the fore-finger.*

Influenza. (Ital. *influenza*, the influence; Fr. *la grippe*). *An epidemic contagious affection of the respiratory mucous membranes.*

Interstitial (*inter*, between, *sto*, to stand). *Standing or situated between;* sometimes spoken of as *fibroid* or *connective tissue.*

Intussusceptio (*intus*, within, *suscipio*, to receive). *One portion of the intestine passing into another.*

Iris (ἶρις, a rainbow, from εἴρω, to tell, because it told the coming of the deluge). *The membrane of the eye, which is perforated to form the pupil.*

Ischuria (ἰσχουρία, from ἴσχω, to restrain, οὖρον, urine). *Difficulty of passing water.*

Jugular (*jugulum*, the throat). *Of or belonging to the throat.*

Keloid (κήλη, tumour ; or κηλίς, a stain, εἶδος, likeness). *Peculiar form of cancroid disease.* *See* Cheloid.

Kynanche. *See* Cynanche.

Lanŭla, æ, f. (*lana*, wool). *Flannel.*

Laryngismus (λαρυγγίζω, to shout lustily, from λάρυγξ, the organ of voice). *A peculiar spasmodic disease of the larynx.*

Laryngismus stridulus. *Spasm of the glottis.*

Laryngitis. *Inflammation of the larynx.*

Laryngoscope (λάρυγξ, the organ of voice, σκόπεω, to look at). *An instrument for examining the larynx.*

Lentīgo (*lens*, a lentil). *Freckles.*

Lepra (λέπρα, leprosy, which makes the skin scaly, from λέπος, a scale, husk, or rind). *Leprosy.*

Lepra tuberculosa. *True leprosy.*

Leucocythæmia (λευκός, white, κύτος, a cell, αἷμα, blood). *White-cell blood.*

Leukæmia (λευκός, white, αἷμα, blood). *Same as* Leucocythæmia.

Lichen, ēnis, m. (λειχήν, tree moss). *Tetter. A skin disease.*

Ligŭla, æ, f. (diminutive of *Lingua*, a tongue). *A sexually mature cestoid worm.*

Lintĕum, i. n. (λίνον, flax). *Lint.*

Lumbrīcus. *Smooth worm.*

Lupus (*lupus*, a wolf). *Lupus, a tubercular ulcerative disease, also called Noli me tangere.*

Lysis (λύσις, a loosing, setting free, from λύω, to dissolve). *The gradual termination of a fever.*

Maculæ (L. *macula*, a spot or stain). *Marks in the skin in typhus fever, purpura, &c.*

Malleus, i, m. *A hammer.*

Mania (μανία, frenzy, from μαίνομαι, to be mad). *Madness.*

Marasmus (μαρασμός, from μαραίνω, to waste or pine away). *Progressive wasting.*

Melæna (μέλας, μέλαινα, μέλαν, black). *Passage of black, tar-like, bloody matter by stool.*

Melanosis (μελάνωσις, a becoming black). *Blackish growth or deposit.*

Melasma (μέλασμα, black or livid spot) supra-renale. *Addison's disease.*

Meningitis (μῆνιγξ, g. μήνιγγος, a membrane). *Inflammation of the membranes of the brain.*

Meningitis tuberculosa. *Tubercular meningitis.*

Menorrhagia (μήν, month, ῥήγνυμι, to break or burst forth). *Excessive menstruation.*

Mentagra (*mentum*, chin, ἄγρα, seizure). *Chin whelk, or Sycosis menti.*

Metallic tinkling. *A sound like that caused by striking glass or metal with a pin, heard in hydro-pneumothorax.*

Metamorphici (μετά, change, μορφή, form) [sci. morbi]. *Developmental disease.*

Mētria. v. metritis (μήτρα, womb). *A form of puerperal fever. Inflammation of the womb.*

Miasmatici (μίασμα, stain or defilement) [sci. morbi]. *Diseases arising from a miasm or infective agent.*

Mica, æ, f. *Crumb.*

Mica panis. *Crumb of bread.*

Microscope (μικρός, small, σκόπεω, to see). *An instrument which magnifies minute objects, so enabling them to be seen and studied.*

Miliaria (*milium*, millet-seed) [sci. Febris]. *Miliary, or sweating fever.*

Mistūra, æ, f. (*misceo*, to mix). *Mixture.*

Mollities ossium (*mollis*, soft). *Softness of the bones.*

Molluscum (Lat., A fungus which grows on the maple tree: Pliny). *A skin disease.*

Monomania (μόνος, alone, single in its kind, μάνια, madness). *Derangement on a single idea.*

Monorganici (μόνος, alone, ὄργανον, organ) [sci. morbi]. *Local diseases.*

Morbilli (Ital., *I morbilli*, dim. of *il morbo*, the plague). *Measles.*

Morbus Pedicularis. *The lousy disease. See* Phthiriasis.

Mutitas, atis, f. *Deaf-dumbness.*

Myelitis (μυελός, marrow). *Inflammation of the spinal marrow.*

Myocarditis (μῦς, a muscle, καρδία, a heart). *Inflammation of the muscles of the heart.*

Nævus (for Gnævus). *A mole or skin mark.*

Necrosis (νέκρωσις, state of death, from νεκρός, a dead body). *Death of bone.*

Nephria (νεφρός, kidney). *Bright's disease.* .

Nephritici (νεφρός, kidney) [sci. morbi]. *Kidney diseases.*

Nephritis (ἡ νεφρῖτις νόσος). *Inflammation of the kidney.*

Neuralgia (νεῦρον, nerve, ἄλγος, pain). *Tic douloureux.*

Neuroma (νεῦρον, nerve). *Tumour of nerve.*

Noma (νομή, a pasture; hence metaphor., νομαί [Lat., *nomæ*], eating or corroding sores). *Canker, cancrum oris.*

Nosocomīum, i. n. (νοσοκομεῖον, from νόσος, disease, κομέω, to take care of). *An hospital.*

Nosologia (νόσος, disease, λόγος, discourse). *Classification of diseases. Nosology.*

Nummular (*nummulus*, a piece of money). *Applied to a form of airless, purulent sputum lying at the bottom of the spitting cup, and having the appearance of small coins.*

Nystagmus (νυσταγμός, drowsiness, from νυστάζω, to nod in sleep). *Oscillation of the eyeballs.*

Obstipatio (*ob*, towards or against, *stipo*, to press). *Constipation.*

Œdēma, atis, n. (οἴδημα, swelling). *Dropsy.*

Œdema glottidis. *Effusion into the areolar tissue of the glottis.*

Œsophagitis (οἰσοφάγος, the gullet or swallow, from οἶσος, osier, the twigs of which served for ropes—hence applied to the rope-like gullet ; φαγεῖν, to eat). *Inflammation of the œsophagus.*

Oidium albicans (ᾠόν, an egg, εἶδος, like ; *albĭco*, to make white, from *albus*, white). *A vegetable parasite seen in aphthous patches.*

Oligæmia (ὀλίγος, few, αἷμα, blood). *Deficiency in the amount of blood.*

Ophthalmia (ὀφθαλμία, from ὀφθαλμός, the eye). *Inflammation of the eye.*

Orchitis (ὄρχις, a testicle). *Inflammation of the testicle.*

Organoleptic (ὄργανον, an organ, λάμβανω, to seize). *Perceived by the senses.*

Orthopnœa (ὀρθόπνοια, upright breathing, from ὄρθος, straight or upright, πνοή, hard breathing). *Difficulty of breathing so great as to cause the patient to sit up.*

Ossium fragilitas. *Brittleness of the bones.*

Ossium mollities. *Softness of the bones.*

Ostitis [more correctly, *Osteitis*] (ὀστέον, a bone). *Inflammation of bone.*

Ovarii hydrops. *Dropsy of the ovary.*

Ovarii tumor. *Tumour of the ovary.*

Paidici (παιδικός, belonging to a child, from παῖς, a child) [sci. morbi]. *Diseases of children.*

Panis, is, f. *Bread.*

Papula. *A minute, elevated spot ; a pimple or papule.*

Paralysis (παράλυσις, from παρά, by, λύω, to loose). *Paralysis, palsy, loss of power.*

Paralysis agitans. *Shaking palsy.*

Paramenia (παρά, aside, *or* beyond, *i.e.*, amiss, *or* wrong, μήν, month). *Disordered menstruation.*

Parasitici (παράσιτος, one who lives at another's expense, from παρά, by, σῖτος, food) [sci. morbi]. *Parasitic diseases.*

Parenchyma (παρέγχυμα, anything poured in beside, παρά, by, ἐν, in, χέω, to pour). *The peculiar substance of organs supported by the interstitial connective tissue of the same.*

Paronychia (παρά, by, or alongside of, ὄνυξ, the nail). *Whitlow.*

Parotia (παρά, by, οὖς, the ear). *The mumps, a specific inflammation of the parotid gland.*

Parotid gland (παρωτίς). The gland beside the ear.

Parotiditis. *Cynanche parotidea, or mumps.*

Paroxysm (παροξυσμός, exacerbation, from παρά, beside, ὀξύς, sharp). *A sudden and severe fit (of illness or bad breathing).* (Lat. *accessio.*)

Partus, ūs (*pario*, to bring forth). *Child-birth.*

Pathology (πάθος, suffering, λόγος, discourse). *The science of disease.*

Pectoriloquy (*pectus*, chest, *loquor*, to speak). *Voice heard like Punch in Punchinello.*

Pedicŭlus, i, m. (*pes*, a foot). *A louse, or creeper.*

Pediluvium, i, n. (*pes*, *g. pedis*, a foot, *luo*, to cleanse). *Foot-bath.*

Pellagra (πέλλα, skin, ἄγρα, seizure). *Pellagra, a skin disease*, observed among the Milanese.

Pemphīgus (πέμφιξ, *g.* πεμφίγος, a bubble). *A bullar eruption.*

Peptone (πεπτός, cooked, from πέσσω, to soften or cook). *Albuminous (proteid) food which has been acted upon (digested) in the stomach.*

Pericarditis (περικάρδιος, from περί, around, καρδία, heart). *Inflammation of the investing membrane of the heart.*

Perityphlitis (περί, around, τυφλός, blind). *Inflammation near or around the blind gut or cæcum.*

Peritoneum (περιτόναιος, stretched over, τό περιτόναιον, from περί, around, τείνω, to stretch). *The peritoneum.*

Peritonitis. *Inflammation of the peritoneum.*

Peritonitis tuberculosa. *Tubercular peritonitis.*

Pertussis (*per*, intens., *tussis*, a cough). *Whooping-cough.*

Petechiæ (Ital. *petecchio*, a flea-bite). *Spots of extravasated blood pigment.*

Pharyngitis (φάρυγξ, *g.* φάρυγγος, the throat). *Inflammation of the pharynx.*

Phthinoid (φθίω, to decay, εἶδος, likeness). *Belonging, or predisposing, to consumption.* (More correct form : "Phthinode," Gk. φθινώδης).

Phthiriăsis (φθειρίασις, from φθείρ, a louse). *Morbus pedicularis, the lousy disease.*

Phlebitis (φλέψ, *g.* φλεβός, a vein). *Inflammation of veins.*

Phlebotomy (φλέψ, a vein, τέμνω, to cut). *Venesection.*

Phlegmon, ŏnis, m. (φλεγμονή, fiery heat, from φλέγω, to burn). *Inflammatory swelling.*

Phrenītis (φρενῖτις, from φρήν, mind). *Inflammation of the brain.*

Phthisis (φθίσις, from φθίω, to decay). *Consumption.*

Pica (Lat. *pīca*, a magpie). *Perverted appetite.*

Pityriasis (πίτυρον, bran). *A skin disease.*

Pityriasis versĭcŏlor (Lat. party-coloured). *A skin affection of parasitic origin, depending on or accompanied by the growth of a fungus, Microsporon furfur.*

Pleuritis (πλευρῖτις, from πλευρόν, a rib). *Pleurisy.*

Pleuro-pneumonia. *Inflammation of the pleura and lungs.*

Pleximeter (πλῆξις, a stroke, from πλήσσω, to strike, μέτρον, a measure). *The ivory plate used in mediate percussion.*

Pneumonia (πνευμονία, from πνεύμων, a lung—cf. πνέω, to breathe). *Inflammation of the lung-substance.*

Pneumonici [sci. morbi]. *Lung diseases.*

Pneumothorax (πνεῦμα, air, θώραξ, chest). *Air in the pleural cavity.*

Podagra (ποδάγρα, lit. a trap for the feet, from πούς, *g.* ποδός, foot, ἄγρα, seizure). *Gout.*

Pomphŏlyx (πομφόλυξ, a water-bubble, from πομφός, a blister on the skin). *A vesicular skin disease.*

Prognosis (πρόγνωσις, a perceiving beforehand, from πρό, before, γιγνώσκω, to know). *Forecast of the result of a disease.*

Prognosticate (προγνωστικός, foreknowing, prescient. *To give a forcast of the result of a disease. See* Diagnosticate.

Prurīgo (*prurio*, to itch). *A skin disease.*

Prurītus *A sense of itching.*

Psoriasis (ψωρίασις, a being itchy or mangy, from ψώρα, itch). *A skin disease.*

Pulex irrītans. *The common flea.*

Pulmo, ōnis, m. *The lung.*

Pulsus, ŭs, m. (*pello*, to beat). *The pulse.*

Pulsus alternans (Lat. *alterno*, to do one thing and then another). *A pulse, of which every second beat is weak or even imperceptible.*

Pulsus bigeminus (Lat. *bigeminus*, doubled, from *bis*, twice, *geminus*, twin-born). *A pulse with a double beat, equal in force, followed by a long pause.*

Pulsus debilis. *Weak pulse.*

Pulsus dicrŏtus (δίκροτος, double-beating, from δίς, twice, κροτέω, to strike). *Double-beating pulse.*

Pulsus durus. *Hard pulse.*

Pulsus formīcans (Fr. *pouls formicant*). *Pulse small and creeping like ants.*

Pulsus fortis. *Strong pulse.*

Pulsus frequens. *Frequent pulse.*

Pulsus inspiratione intermittens. *The paradoxical pulse* (Kussmaul).

Pulsus intermittens. *Intermitting pulse.*

Pulsus malleāris (Lat. *mallĕus*, a hammer). *Hammer-like pulse (of aortic regurgitation).*

Pulsus mollis. *Soft pulse.*

Pulsus normalis. *Regular pulse.*

Pulsus paradoxus (παράδοξος, contrary to opinion, strange, from παρά, beside, δόξα, opinion, δοκέω, to think). *A pulse unequal in rate, slow in expiration, more frequent in inspiration.*

Pulsus parvus. *Small pulse.*

Pulsus plenus. *Full pulse.*

Pulsus rarus. *Infrequent pulse.*

Purpura (Gk. πορφύρα, the purple fish). *The purples, dissolution of the blood.*

Purpura hæmorrhagica. *Purpura, with hæmorrhages from the skin and mucous membranes.*

Pustula, æ, f. (Fr. *pus*, Gk. πύον, matter or pus). *Pustule.*

Pustula maligna. *Malignant pustule*—name for malignant anthrax (Fr. *charbon*).

Pyæmia (πύον, matter or pus, αἷμα, blood). *Pyæmia.* (State resulting from absorption of pus).

Pyrexia (πυρέσσω, fut. πυρέξω, to be feverish, from πυρετός, fever). *The constitutional state of fever or inflammation.*

Pyrosis (πύρωσις, a burning, from πῦρ, fire). *Water-brash, sour burning eructations, heartburn.*

Rachitis (ἡ ῥαχῖτις [sc. νόσος], from ῥάχις, spine). *The rickets.*

Râle (Fr. *râle*, a rattle). *An adventitious sound produced by impediment to the entry or escape of air within the lungs or bronchial tubes.*

Rheumatism (ῥευματίζομαι, to have or suffer from a flux, from ῥεῦμα, catarrh).

Rhonchus, i, m. (ῥόγχος = ῥέγχος, a snoring sound, from ῥέγχω, to snore). *A dry rattle or râle.*

Rigor, ōris, m. *Stiffness, coldness, shivering fit.*

Rigor mortis. *Stiffness of limbs after death.*

Roseola (Lat. *rosa*, a rose). *Rose-rash.*

Rötheln (Germ. *roth*, red). *Epidemic Rose-rash.*

Rubella (dim. of *rubeola*). *A name for Rötheln.*

Rubeola (Lat. *ruber*, red). *Measles.*

Sarcīna ventriculi (Lat. *sarcīna*, a package or bundle, from *sarcio*, to mend). *A vegetable parasite*, occasionally found in sputum, vomited matter, &c., and resembling tied up packages or bundles. [See page 284.]

Scarlatina (Ital. *scarlátto*, or *scarlattīno*, scarlet cloth). *Scarlatina, scarlet fever.*

Scirrhus (σκῖρος, any hard coat or covering, induration). *Hard cancer.*

Sclerema (σκληρός, hard, Lat. *durus*). *Induration of the interstitial connective or areolar tissue.*

Sclerosis (σκληρός [Lat. *durus*], hard, tough). *An increase and subsequent induration of connective tissue,* which may destroy the natural structure by pressure.

Scoliosis (σκολίωσις, crookedness, from σκολιός, crooked, curved, bent). *Rotato-lateral curvature of the spine.*

Scorbutus, i, m. [not classical Latin] (Fr. *le scorbut*). *Scurvy.*

Scrofulæ (*scrōfa*, a sow). *Strumous disease, king's evil, scrofula.*

Semeiology (σημεῖον = σῆμα, a sign, mark, token, λόγος, discourse). *The study of signs and symptoms of Disease.*

Senectus, ūtis, f. (Lat. *senex*, old). *Old age.*

Somnus, i, m. *Sleep.*

Somnus altus. *Deep sleep.*

Sordes, is, f. (filth). *Foul matter on teeth, lips, &c.*, consisting of shed epithelium, portions of food, blood, and *débris.*

Soufflé voilé (Fr. *soufflé*, a puff). "*Veiled puff,*" *a variety of cavernous breathing.*

Soufflet (Fr. *soufflet*, a bellows). *A variety of murmur, like the sound made by air escaping through the nozzle of a bellows. Bellows murmur.*

Spanæmia (σπανός, rare—*in composition*: lacking, αἷμα, blood). *Blood, of which the corpuscular or solid constituents are reduced in amount.*

Spasms (σπάσμος, a convulsion, from σπάω, to draw out). *Convulsions, or sudden, sharp, internal pain.*

Spasms—clonic (κλόνος, a violent confused motion, tumult). *Sudden, violent and interrupted muscular contractions.*

Spasms—tonic (τείνω, to stretch or strain to the utmost). *Continuous and sustained muscular contractions.*

Spermatozoon (σπέρμα, *g.* σπέρματος, seed, ζῷον, a living being). *Seminal animalcule.* [See page 274.]

Sphygmograph (σφυγμός, the throbbing pulse [from σφύζω, to throb], γράφω, to write). *An instrument for recording the pulse-trace.*

Splenītis (σπλήν, the milt or spleen). *Inflammation of the spleen.*

Sputum, i, n. (lit., spit, spittle, from Lat. *spuo* [Gk. πτύω], to spit out, to spew). *Expectoration.*

Squama, æ, f. *A scale.*

Stenōsis (στείνω, to make narrow). *Contraction of a vessel or orifice.*

Stertor (*stertĕre*, to snore). *Snoring noise.*

Stethoscope (στῆθος, chest, σκοπέω, to view). *Instrument to explore the chest.*

Stomatitis (στόμα, the mouth). *Inflammation of the mouth.*

Struma (Lat., *struo*, to pile up). *Scrofulous disease.*

Sudamina [not classical] (*sudo*, to sweat [Gk. root ἰδ, *cf.* ἵδρως, *sudor*, perspiration]). *Sweat vesicles.*

Symptomatology (σύμπτωμα [lit., a falling in, from σύν, together, πίπτω, to fall], a symptom, λόγος, discourse). *The same as Semeiology* (*q. v.*).

Syncope (συγκοπή [lit., a cutting up, from συγκόπτω, to beat together, to cut up], sudden loss of strength, swoon). *Fainting.*

Synŏcha (συνοχή, a meeting or joining, from σύν, with, ἔχω, to hold). *Continued inflammatory fever.*

Synovia (σύν, with, ᾠόν, egg). *Fluid like white of egg.*

Syphilis (etymology unknown—if from σύν, with, φιλέω, to love, the word should be "Symphilis"—perhaps from σιφλός, crippled, maimed, defective). *The venereal disease.*

Systole (συστολή, a drawing together, contraction, from σύν, with, στέλλω, to set). *The contraction of the heart's chambers to propel the blood.*

Tabes (root in Gk., τήκω, to melt). *Emaciation.*

Tabes mesenterica (τὸ μεσέντερον [sci. δέρμα], the membranes to which the intestines are attached, from μέσος, in the middle, ἔντερον, the intestine). *Wasting and inanition from strumous deposit in the mesenteric glands.*

Tænia (ταινία, a fillet, from τείνω, to stretch). *Tapeworm*, of which there are several species.

Tetanus (τέτανος, a convulsive tension of the body, from τείνω, to stretch). *A disease with violent muscular spasms.*

Therapeutics (ἡ θεραπευτική τέχνη, from θεραπεύω, to heal). *The science and art of healing.*

Thermometer (θέρμη, heat, μέτρον, a measure).

Tonsillia (from Lat. *tonsillæ*, the tonsils. *Tonsillitis, quinsy. Cynanche tonsillaris.*

Trachēa (ἡ τραχεῖα ἀρτερία, *i.e.*, the rough air-duct). *The wind-pipe.*

Trachealia. *Croup. Cynanche trachealis.*

Tuberculosis (*tuberculum* [dim. of *tuber*, a bump], a tubercle). *Tubercular disease.*

Tuberculosis mesenterica. *Same as Tabes mesenterica* (*q. v.*).

Tussis, is, f. *Cough.*

Tympanītes (τύμπανον, a kettle-drum). *Flatulent distension of the bowels.*

Tympănum, i, n. (τύμπανον, a kettle-drum). *The middle ear.*

Typhlītis (τυφλός, blind). *Inflammation of the cæcum—that is, the "blind" gut. See* Perityphlitis.

Typhoid fever—febris typhoides (τῦφος, εἶδος) [from its likeness to typhus]. *Enteric or typhoid fever.*

Typhus fever—febris typhosa (τῦφος, stupor). *Spotted, maculated, or petechial fever.*

Typhus icterodes (ἰκτερώδης, jaundiced). *Yellow fever.*

Umbĭlīcus (Lat. *umbilīcus* [akin to Gk. ὀμφαλός]). *The navel.*

Uræmia (οὖρον, urine, αἷμα, blood). *A form of blood-poisoning,* due to retained urea or the products from which it is derived.

Urinometer (οὖρον [Lat. *urīna*], urine, μέτρον, a measure). *An instrument for taking the specific gravity of the urine.*

Urticaria (Lat., *urtīca*, a nettle, from *uro*, to burn). *Nettlerash.*

Vaccinia (Lat., *vacca*, a cow). *Vaccine disease or cowpox.*

Valvula (Lat. *valvolæ*, valvules of leguminous plants; dim. of *valva*, the leaf of a door). *A valve.*

Varicella (dim. of *Variola*). *Chicken pox.*

Varicocele (Lat. *varix*, a dilated vein, κήλη, a tumour). *Swelling of a vein.*

Variola (Lat. *varus*, a pimple). *Smallpox* [Fr. *la petite vérole*, Ital. *la vaiuōle*].

Varioloīdes. *Varioloid, or modified smallpox.*

Varix, ĭcis, m. (*varus*, stretched). *A dilated or varicose vein.*

Vermis, is, m. (Gk. ἕλμινς, *g.* ἕλμινθος). *Worm.*

Vertīgo, vertīgĭnis (Lat., from *verto*, to turn). *Giddiness, dizziness.*

Vesīcŭla (dim. of *vesīca*, the bladder). *A vesicle.*

Viæ primæ (first ways or passages). *The digestive tract. The stomach and intestines.*

Vibex, vībīcis. *A purple stripe or mark. A weal.*

Vibrio, ōnis, f. (*vibrare*, to quiver). *An infusory animalcule.*

Vŏmĭca (Lat. *vomica*, a sore, abscess, encysted tumour). *A cavity in the lung caused by breaking down of its substance.*

Zymōtici (ζύμη, leaven) [sci. morbi]. *Zymotic diseases, or those produced by a morbific agent acting on the organism like a ferment.*

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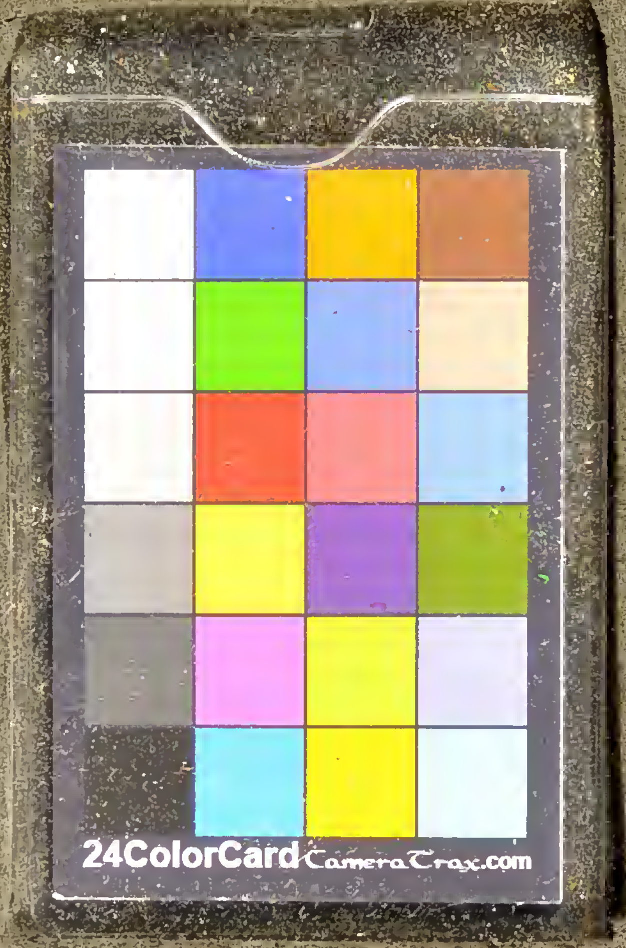
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